INTEGRATED WATER RESOURCES MANAGEMENT IN CAMBODIA

The Stung Sen pilot case

A review of 10 years of partnership between France and Cambodia 2012-2022

Kampong Phluk floating village.
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A REVIEW OF 10 YEARS OF PARTNERSHIP BETWEEN FRANCE AND CAMBODIA

The Stung Sen pilot case

Integrated Water Resources Management in Cambodia 2012-2022

A floating village on the Tonle Sap.
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Integrated water resources management (IWRM) is a new approach for Cambodia. Thanks to a fruitful collaboration with France and the invaluable support of the Loire-Bretagne and Rhin-Meuse water agencies, the International Office for Water, the Agence Française du Développement, and the Asian Development Bank, we have made remarkable progress in the space of just ten years. Working closely with the Stung Sen river basin management committee, under the direction of the Tonle Sap Authority (TSA), we have achieved promising results.

The choice of the Stung Sen river basin as a pilot project was crucial. The knowledge acquired on surface and ground water resources constituted a solid foundation that has guided every stage of this project. Thanks to the research carried out, we are able to better manage and respond to the needs of all users throughout the year.

The policy of the Ministry of Water Resources and Meteorology (MOWRAM) aims to anticipate the risk of flooding and drought, and to guarantee sustainable use of water.

Featuring seven river basins that cover the entire territory of 181,035km^2, Cambodia is currently setting up a national river basin management committee. With this in mind, we call on the financial and technical support of our partners to develop a methodology that corresponds to to the Cambodian context in order to pragmatically study integrated water resources management (IWRM) for each individual

river basin. The successful experience of the Stung Sen IWRM project will act as a benchmark to reach this objective.

I would like to express my sincere gratitude to our French partners for their valuable collaboration, and to the Tonle Sap Authority for accomplishing the tasks. Thanks to their contribution, we have made significant progress both on the institutional level and in the implementation of decentralised action.

I hope you enjoy reading this report and remain confident of our capacity to pursue our efforts for more effective, sustainable integrated water resources management in Cambodia.

Lim Kean Hor
Minister of Water Resources
and Meteorology of Cambodia


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The Loire-Bretagne and Rhin-Meuse water agencies are proud to celebrate ten years of institutional partnership with the Ministry of Water Resources and Meteorology of Cambodia, the Tonle Sap Authority and the International Office for Water relating to the integrated water resources management project in the Stung Sen river basin. The history of this partnership is described in this report, which we hope will inspire the vocation and enthusiasm to reproduce the project elsewhere.

At the request of our Cambodian partners, our common objective was to protect aquatic ecosystems, improve the quality of life of local inhabitants thanks to better access to drinking water and sanitation, and guarantee responsible management of water resources.

We are pleased to observe the significant progress in water management made in Cambodia thanks to our collaboration, even though we know that much remains to be done. Together, we have learned a lot from each other and seen through some important projects, including the establishment of the first basin committee, a programme of measures, and the first operations for access to drinking water and sanitation in villages.

We are convinced that this partnership will continue to produce positive results for local inhabitants and aquatic ecosystems for sustainable water management.

We warmly thank all those involved in this project for their commitment and collaboration over the last ten years, and reaffirm our desire to continue this emblematic cooperation with the Tonle Sap Authority to serve future ambitions.

Enjoy reading,

Martin Gutton, Director General
of the Loire-Bretagne Water Agency

Marc Hoeltzel, Director General
of the Rhin-Meuse Water Agency


Hydrological station in the Stung Sen basin.
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Floating village with houses at Konpong Phlouk on the banks of the Tonle Sap lake.
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KEY FIGURES
ON THE STUNG SEN RIVER BASIN INTEGRATED WATER RESOURCES MANAGEMENT (IWRM) PROJECT

520Km
Length of main river

16,344Km²
Size of catchment area

7,373Km
River network the basin

2013 → **75**
2015 → **65**
2022 → **83**
Committee Basin members

10 years
Duration of partnership

13 districts
71 municipalities
492 villages

561,251 people
Basin population

Water quality monitoring
14 physicochemical parameters
including
4 heavy metals and
3 bacteriological

245.5 m³/s
Inter-annual flow at Kampong Thom

DRINKING WATER
7 stations
built (+4 to come)

Meteorological monitoring
7 automatic stations

Hydrological monitoring
6 automatic stations

18.5%
Rural population connected to the supply and standpipes

60
municipalities (85%) questioned in surveys

HISTORIC PARTNERSHIP

CHAPTER 1

A decade of fruitful collaboration between Cambodia's Ministry of Water Resources and Meteorology, the Tonle Sap Authority, the Loire-Bretagne and Rhin-Meuse water agencies and the International Office for Water: a solid partnership for the preservation of water resources.
For the past ten years, these partners have been working together to protect and sustainably manage the vital Stung Sen and Tonle Sap ecosystems, providing an outstanding example of international cooperation for water. ●

Stung Sen and its corridor, Phat Sanday Biosphere Reserve.
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Cambodian partners

Ministry of Water Resources and Meteorology of Cambodia (MOWRAM)

Cambodia's Ministry of Water Resources and Meteorology (MOWRAM) was created by Royal Decree on 23 June 1999 to manage national water resources.

In accordance with the law on water resources management promulgated in 2007, the ministry's missions include:

• definition of policies and strategies concerning water resources management to ensure economic growth while guaranteeing sustainable development;

• acquisition and analysis of scientific knowledge: study of hydric potential, hydrological and meteorological data;

• establishment of water resource management plans;

• advice to economic actors, communities and the general public to optimise water withdrawals and usage;

• prevention of crisis situations (floods, droughts) and their management;

• preparation of regulations and legislation related to water resources management;

• participation in works concerning the Mekong basin (Mekong River Commission);

• reinforcement and extension of national and international cooperation in the field of water resources management and meteorology.

The ministry is responsible for ensuring effective, sustainable management of water in Cambodia, involving the actors concerned, and adopting a modern scientific and technological approach.

Meeting of the Stung Sen Basin Executive Commitee on 17 December 2019.
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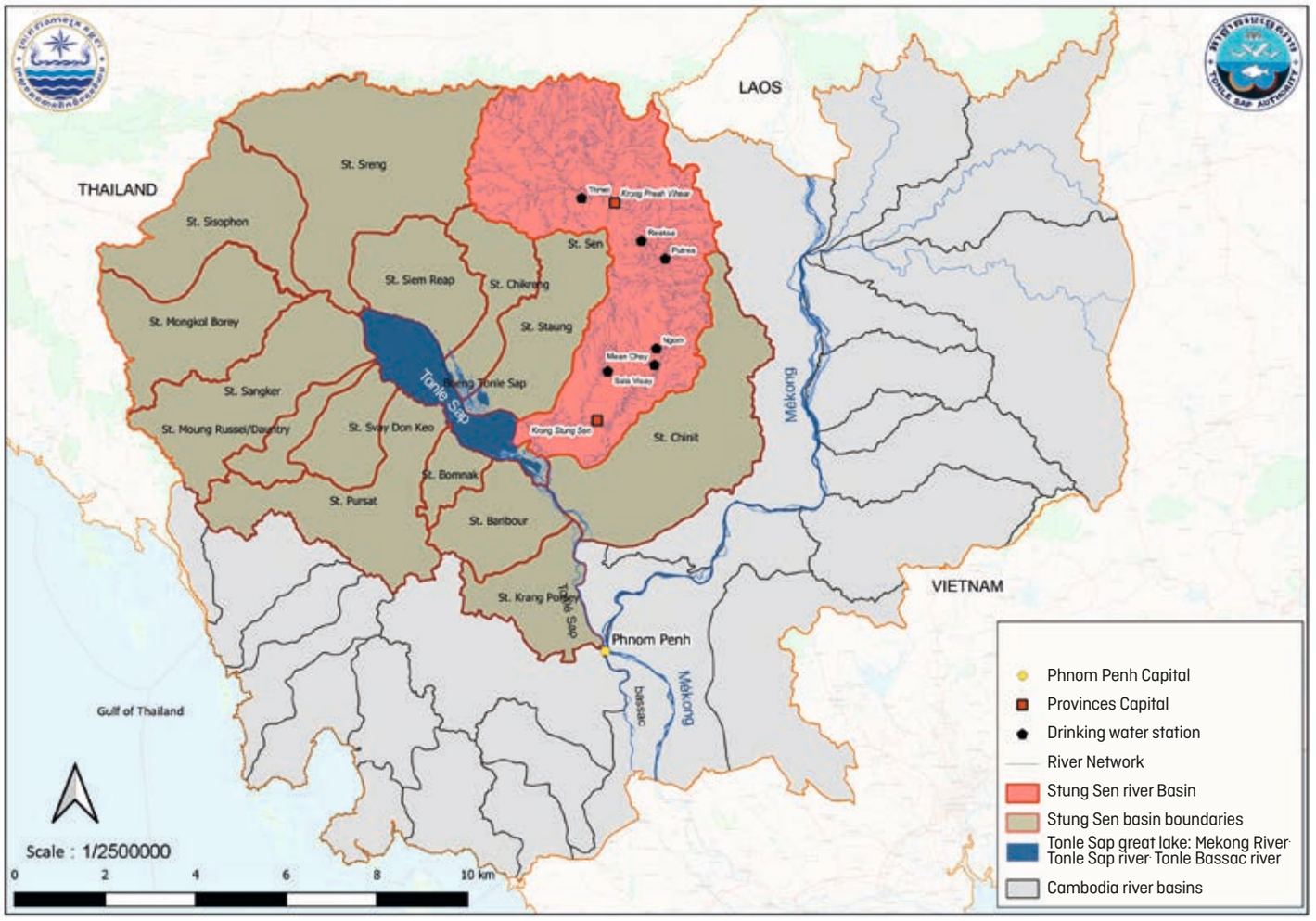

The Stung Sen watershed in Cambodia

The Tonle Sap watershed consists of 11 sub-basins of which the largest tributary is the Stung Sen.

SOURCE TSA

Tonle Sap Authority

Tonle Sap Authority (TSA), placed under the authority of MOWRAM, was established by royal order № NS/RKOT/0609÷705 of 29 June 2009 to facilitate the management, conservation and development of the area of the Tonle Sap great lake and its tributaries.

On behalf of the royal government, its main objective is to coordinate and work with ministries, institutions, local authorities and development partners in order to establish strategic plans and management programmes for the Tonle Sap in a concerted manner.

Tonle Sap Authority is also responsible for monitoring and evaluating projects that impact water resources to encourage operators to implement the royal government's strategy and management plan.

In addition, the Tonle Sap Authority collects, analyses and updates information and data for dissemination and sharing with stakeholders. It also plays a role to educate and raise awareness among the general public.

As a result, Tonle Sap Authority comes directly under the royal government and works closely with all institutional and economic actors to facilitate the management, conservation and development of the area comprising the Tonle Sap great lake and its tributaries.

Project launch mission in Cambodia, 2012. From left to right: Michel Stein, Alain Bernard, Philippe Sennhauser, Sophie Lelchat, Christian Szacowny, Lim Puy, Jacques Oudin, Daniel Morabito.
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French partners

Loire-Bretagne and Rhin-Meuse water agencies

The Loire-Bretagne and Rhin-Meuse water agencies are French public establishments that come under the French Ministry for an Ecological and Inclusive Transition.

The agencies work in coordination with the Ministry of Foreign Affairs, the Agence Française de développement, and French international cooperation actors to promote integrated water resources management (IWRM) at hydrographic basin scale. They can employ up to 1% of their budget to support cooperation projects in the water domain run by local authorities, associations, and NGOs.

The Water Agencies' international cooperation is of two types: institutional partners, and local programmes for access to basic water resources.

Institutional partnerships aim to promote concerted, partnership-based water management at river basin scale by sharing skills and knowledge. The agencies play a double role of financial donor and technical expert.

Local programmes concerning access to basic water services are established as part of international solidarity action. The programmes involve financial and technical support to set up projects targeting access to drinking water and sanitation led by local authorities and associations in their basins.

The Loire-Bretagne and Rhin-Meuse water agencies work with the International Office for Water (OiEau), which acts as a technical operator to coordinate and implement this institutional partnership with MOWRAM, the TSA, and local associations and authorities. The agencies also provide technical expertise through their agents to support and advise their Cambodian peers and partners.

The interaction between institutional cooperation and local programmes to access essential water services constitutes an exemplary model of intervention that the water agencies are keen to showcase in their common strategy for international cooperation to promote sustainable, fair management of water.

International Office for Water

The International Office for Water (OiEau) is a non-profit association subject to French law established in 1991 and officially recognised as such by the Decree of 13 September 1991, renewed on 16 September 2020.

The main objective of OiEau is to develop competencies for better water management in France, Europe and around the world. To achieve this target, its domains of expertise cover both the short and long water cycles. This technical, operational, institutional, legal and strategic expertise is delivered to all water stakeholders at all levels, from local authorities to national and transborder policies.

OiEau has been involved in the IWRM pilot project in the Stung Sen river basin since the start of the project in 2012 in order to coordinate institutional cooperation actions on behalf of the Loire-Bretagne and Rhin-Meuse water agencies and working directly with local partners. OiEau contributes to this project in three areas:

- establishment of an IWRM process on the Stung Sen river basin: creation and running of a basin committee, basin characterisation, participative planning, development of water information systems, technical reporting;
- support at national level: to prepare decrees and sub-decrees and national methodological guides;
- training of trainers in Cambodia and France on priority themes identified by the Cambodian partners.

Among the strategic areas defined by the water agencies, the interaction between institutional project support for actions to ensure access to basic water services is a major priority. To this end, OiEau plays a facilitating role to foster this interaction by creating a space for exchanges and discussions between the Tonle Sap Authority and the international solidarity project leaders present on the territory.

Signature of the first Memorandum of Understanding (MoU) formalising the collaboration between the Tonle Sap Authority represented by Puy Lim and the International Office for Water represented by Alain Bernard 2012.
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Origins of the Project

In 2011, the Loire-Bretagne water agency was involved in international partnerships with the aim of fostering exchanges of experience on integrated water resources management (IWRM). The objective, which is still valid, was to share knowledge with the idea of learning from each other. For over 50 years, the agency has been developing different IWRM actions at the scale of the Loire-Bretagne basin. After establishing successful partnerships in Vietnam and Laos, the Loire-Bretagne water agency set its sights on a new location: Cambodia, which features exceptional hydrographic networks including the Mekong River, the Tonle Sap great lake, and the Mekong Delta, along with some remarkable biodiversity.

In late 2011, the chairman of the Loire-Bretagne international commission, Mr Jacques Oudin, the head of international action at the Loire-Bretagne Water Agency, Mr Michel Stein, and the head of the Africa, Southeast Asia and Latin America Department at the International Office for Water, Mr Alain Bernard, set off for Phnom Penh. Their mission was to meet Mr Lim Kean Hor, Minister of Water Resources and Meteorology (MOWRAM), accompanied by Mr Lim Puy, Vice Chairman of the Tonle Sap Authority, to discuss a potential institutional partnership.

The three parties met and discussed the challenges of water management in Cambodia. They shared their experiences and knowledge. At the end of the meeting, based on the expectations expressed by the Minister, they knew that they had found common ground. They had decided to embark on a partnership to establish a project for integrated water resources management, choosing the Stung Sen as a pilot basin.

It was the start of a whole new adventure for the Loire-Bretagne Water Agency, the Rhin-Meuse Water Agency, the International Office for Water, and their Cambodian partners: MOWRAM and Tonle Sap Authority. The Stung Sen river basin pilot project was born.

Together, they worked tirelessly to develop new approaches to water management adapted to local features in close contact with local authorities, the water users. This initiative was the first of its kind in Cambodia.

© TSA

Puy Lim
Vice-Chairman
of Tonle Sap
Authority

« These last ten years that have seen Integrated Water Resources Management on the Stung Sen represent both a long and a short amount of time. Although the inhabitants of the basin have access to water in sufficient quantities, the recent impacts of climate change generate increasingly acute droughts and floods. The government has set a priority target of 2030 to establish access to drinking water, electricity, education and communication channels. In this context, the Stung Sen project serves as a valuable model. »

Typical floating village on the Tonle Sap lake with the Mea Chrey pagoda.
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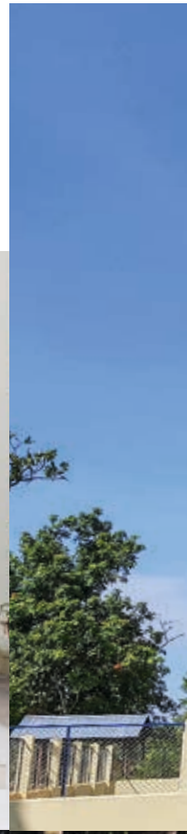


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Project history

During the **World Water Forum** 1 that took place in Marseille in 2012, Mr Lim Kean Hor, Minister of Water Resources and Meteorology, Mr Serge Lepeltier, Chairman of the Loire-Bretagne Basin Committee, Mr Noël Mathieu, Director General of the Loire-Bretagne Water Agency, and Mr Puy Lim, Vice Chairman of the Tonle Sap Authority, signed a memorandum of understanding that confirmed their commitment to work together. The partners were determined to make the project a reality, and the Rhin-Meuse Water Agency quickly joined the team.

A few months later, in October 2012, in Phnom Penh, the Tonle Sap Authority and the International Office for Water (OiEau) signed the memorandum of understanding under the presidency of the minister, enacting the launch of the project.

On **10 January 2013**, the Minister of MOWRAM made a key decision: to put together a **project team at the TSA** comprising members keen to develop their knowledge and committed to seeing the project take shape. This team has remained faithful to the initiative, thus contributing to its long-term success.

Since then, five successive phases have been rolled out and the partners have worked hand in hand to put together a long-term integrated water resources management (IWRM) programme adapted to specific local features.

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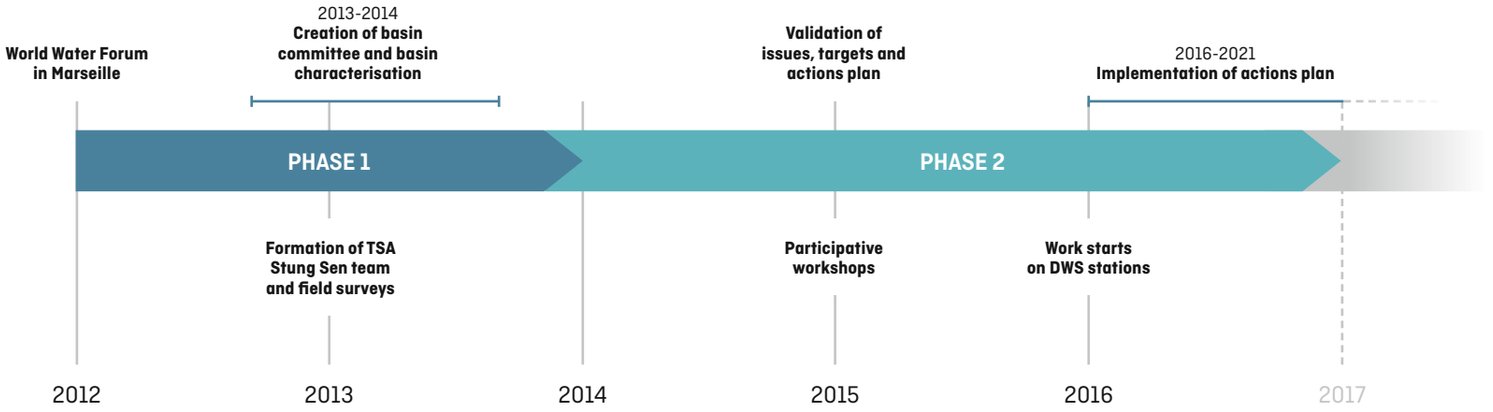
Timeline of the Integrated Water Resources Management (IWRM) project on the Stung Sen river basin



Work was initiated with decentralised ministerial departments present in the two provinces, provincial authorities, municipal representatives, and water users to establish a participative, inclusive water management model.

This collaboration created a genuine synergy of efforts and skills that led to accomplishing the numerous actions described in the following chapters to envisage a more sustainable, prosperous future for the next generations.

The first months of 2013 were marked by sustained activity on the Stung Sen river basin pilot project. Experts from the Loire-Bretagne Water Agency started to **train the Tonle Sap Authority team** in Integrated Water Resources Management (IWRM) ❷. This was a key stage to help young professionals better understand the issues involved in water management.

The project reached a second stage on **28 October 2013, with the first meeting of the Stung Sen River Basin Committee** ❸. This historic meeting was chaired by His Excellency Lim Kean Hor, minister of Water Resources and Meteorology and chairman of the Tonle Sap Authority. The event laid the foundations of water governance and management and officially launched the Stung Sen river basin pilot project.

Throughout 2014, the Stung Sen river basin was the focus of a great deal of attention. **Field studies** were carried out to look closely at water uses and establish a characterisation of this natural basin ❹.

During the next year, 2015, collective discussions were carried out within the basin committee to identify the challenges and main expectations of the Stung Sen river basin and define an ambitious actions plan in response. **The basin committee representatives validated all of these concrete proposals** ❺.

From 2016, in parallel with this institutional cooperation, **socially responsible projects began to emerge to facilitate access to drinking water** ❻. Thanks to the joint efforts of the water agencies, the TSA, Gescod (regional multi-actor network of the Grand Est), and French NGOs,

Field mission in floating villages. © TSA

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Sophie Lelchat

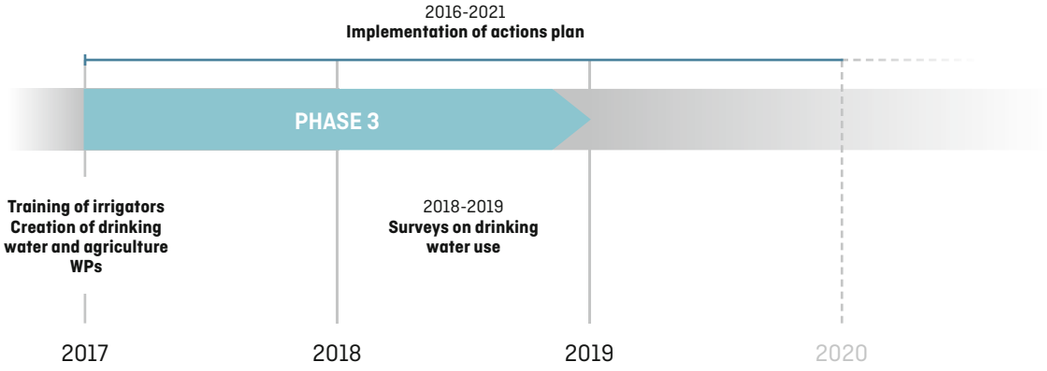
Expert at the Loire-Bretagne Water Agency

« The strength of this partnership is that it brings together institutional cooperation and socially responsible projects, notably by planning works for access to drinking water for priority rural communities. Another key point is the creation of the Stung Sen river basin committee, which has facilitated integrated water resources management thanks to the commitment of all actors concerned. These results show the importance of collaboration and dialogue for the success of common projects. After ten years of partnership, the time has come to look back at what we have learned in order to reinforce sustainable actions to preserve such valuable water resources. »

over the next few years, four drinking water stations were built in the most remote municipalities of the province of Preah Vihea: Thmey, Reaksa, Putra and Teuk Krahorm. In Kampong Thom province, three other stations were constructed, in the municipalities of Ngon, Meanchey and Sala Visay. Local inhabitants could therefore benefit from access to clean, healthy water.

In 2017, efforts continued with the creation of two working groups at the basin committee. The first centred on agriculture, and in particular **irrigation** ❼. The second focused on drinking water, following the work done over the last few years to lay the foundations of more rational, responsible water management. These working groups also received **specific training** ❽.

During 2018 and 2019, **field surveys were carried out** in riparian municipalities to sound out expectations and raise awareness of Stung Sen communities **on drinking water issues** ❾. The results of these surveys led to a clearer understanding of the specific water



Training on good farming practices and the impact on water resources. © TSA

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Alain Bernard

Head of the Africa, Latin America and Southeast Asia Department at the International Office for Water

« Over the last ten years of Franco-Cambodian cooperation, we have learned a great deal together in a mutually beneficial relationship. This long-term collaboration has involved training trainers in a sustainable, adapted way that ensures that they are capable of transmitting their knowledge in turn. Those acting in the Stung Sen river basin now possess the tools they need to ensure integrated water resources management. The basin, which is still in a largely natural state, is starting to suffer from the impacts of development, including the construction and operation of the first dam on its main watercourse in 2022. We hope that this fruitful partnership will continue for the years to come and that it will lead to even better integrated management in Cambodia with new achievements to benefit local people. »

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9 © TSA

10 © TSA

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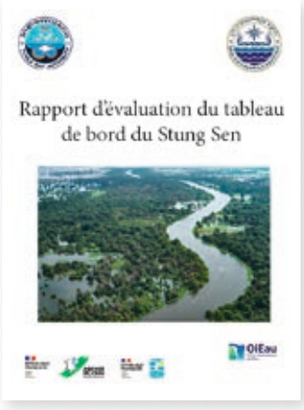

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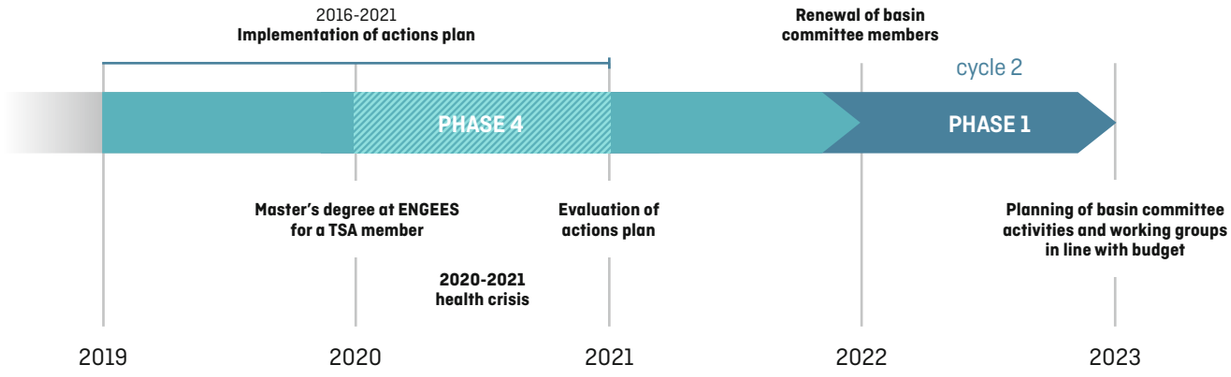


needs of individual villages, their means of consumption, and the different sources of drinking water, and identified opportunities to develop new resources. This diagnosis also launched a reflection on creating the Stung Sen Water Basin Association with an objective of developing access to drinking water in villages by providing technical expertise and skills in governance and project management. In parallel, **capacity-building activities were organised in France and Cambodia to continue training trainers** ⑩.

Despite the 2020-2021 health crisis that unfortunately slowed down the pace, the determination of all partners allowed the project to pursue the project activities. A member of the TSA travelled to Strasbourg, France to follow a **specialised master's degree at ENGEES** ⑪ (national school for water and environmental engineering) on water catchment area management. An evaluation was carried out to consolidate the competencies acquired, leading to the **launch of a second phase of Integrated Water Resources Management (IWRM)** ⑫ in December 2022.

At the start of this new phase, **the composition of the basin committee was revised** ⑬ to better represent water users and make decisions more efficiently. The concretisation of the Stung Sen Water Basin Association continued with the signature in 2021 of a decentralised cooperation agreement between the TSA and the Alsace Moselle water and sanitation authority (SDEA). On Christmas Day, 25 December 2022, the Stung Sen Water Basin Association was recognised by the Ministry of the Interior, a gift of hope for rural communities.

This new period also saw the inauguration of four new water treatment stations: two in Kampong Thom province and two in Preah Vihea province.

Over the years, this Stung Sen pilot project has overcome challenges and proved a true success and a source of inspiration for initiatives in other regions, like the WAT4CAM (Water Resources Management and Agro-ecological Transition for Cambodia) project in the Stung Sangker basin. The results of these projects are mutually shared, thus feeding into the collective knowledge bank.

SOMMARY / CHAPTER 1

STUNG SEN: 10 YEARS OF FRUITFUL PARTNERSHIP BETWEEN FRANCE AND CAMBODIA FOR SUSTAINABLE WATER MANAGEMENT

→ Since 2012, the Cambodian Ministry of Water Resources and Meteorology (MOWRAM) and the Tonle Sap Authority (TSA) have piloted an integrated water resources management project in the Stung Sen river basin.

→ Integrated Water Resources Management (IWRM) had been regularly evoked in Cambodia since 2005, yet few concrete measures had been put in place. MOWRAM and TSA took the initiative of embarking on this project in 2012. The Stung Sen river basin became the first of its kind in Cambodia, thanks to institutional and financial support from the Loire-Bretagne and Rhin-Meuse water agencies with the International Office for Water acting as technical operator of the partnerships.

→ Over these ten years, five action phases were implemented in order to formulate and set out a sustainable integrated water resources management programme adapted to local features.

→ The originality of this project is the imbrication between institutional cooperation and international solidarity projects, benefiting from the financial support of French water agencies. This partnership has facilitated the implementation of tangible measures to ensure sustainable water management, including access to drinking water in priority municipalities.

→ Thanks to this fruitful partnership between France and Cambodia, the integrated water resources management project for the Stung Sen river basin has been a resounding success, thus contributing to promoting sustainable water management on this territory.

STUNG SEN RIVER BASIN

CHAPTER 2

The Stung Sen river basin is subject to numerous environmental and socio-economic challenges. Human activities in the region, such as agriculture, forestry and mining, fishing, aquaculture, urbanisation and tourism, have a significant impact on natural resources and water quality.

To understand the state of the Stung Sen river basin, it was therefore important to collect numerous data on the basin's physical, hydrological, ecological, social and economic aspects.

A comprehensive characterisation of the Stung Sen basin required taking a multidisciplinary approach that integrated qualitative and quantitative data from different sources. The overview of the knowledge acquired presented in this chapter shows how the actors strove to understand the river basin's environmental and socio-economic challenges and conceive an effective, sustainable integrated water resources management (IWRM) strategy. ●

Stung Sen in its upstream section near Preah Vihea province.
© TSA

Regional context, Mekong River Basin, Tonle Sap great lake and Stung Sen River

The Mekong

Crossing Cambodia from north to south, the Mekong River, which is about 4,900km long (MRC, 2010), has its source in the Tibetan Plateau and flows into the southern China Sea after crossing China, running along the Myanmar border, through Thailand then Laos and finally Cambodia and Vietnam. Considered to be the tenth longest river in the world, it drains the waters from a river basin covering 795,000km^2 (MRC, 2010).

Tonle Sap great lake

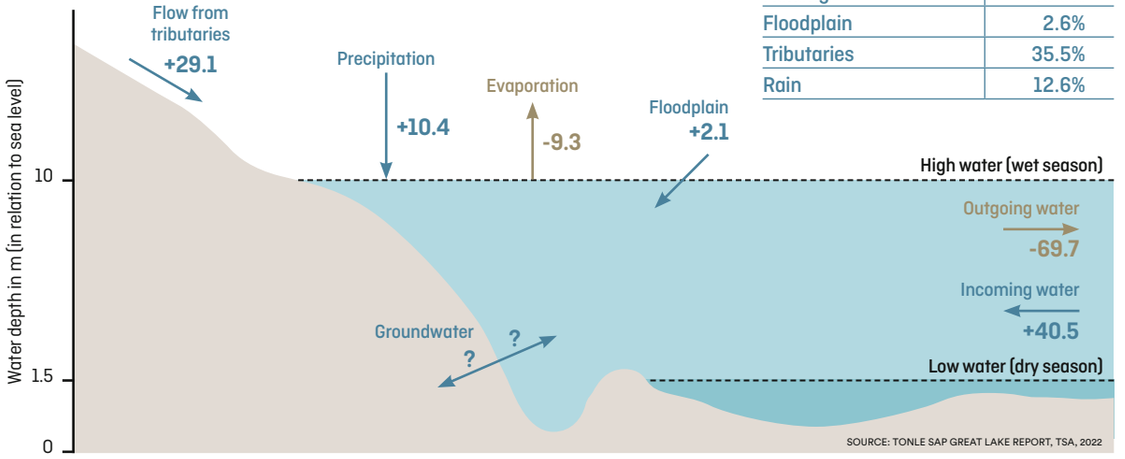
Tonle Sap great lake (TSGL) and its floodplain located in the heart of Cambodia forms the largest natural freshwater environment in Southeast Asia and each year absorbs about 20% of the Mekong's flood waters.

From the dry season to the rainy season, the surface area, volume and depth vary considerably (see image below), with an average volume of 43.2km^3.

The annual inflow of the Tonle Sap comes from the following four sources:

- 49.3% from the Mekong River during the rainy season, which represents 82.1km^3
- 2.6% via the floodplain when the depth of the Kampong Cham water station exceeds 12m
- 35.5% from the 11 tributaries of the TSGL, or 29.1km^3, of which 30% from the Stung Sen
- 12.6% from precipitation, or 10.4km^3

Tonlé Sap returns about 70km^3 to the Mekong in low water periods, and about 9.3km^3 undergo an evapotranspiration process. No information is available on the groundwater.



SOURCE: TONLE SAP GREAT LAKE REPORT, TSA, 2022

Total incoming water: 82.1km^3	
Origin	
Mekong	49.3%
Floodplain	2.6%
Tributaries	35.5%
Rain	12.6%

THE MEKONG RIVER BASSIN

Length: **4,909km**, from the Tibetan Plateau to the ocean

Population on the river basin: **65 million**

Basin surface area in Cambodia: **20%** of 795,000km^2

Quantity of water/year in Cambodia: **18%** of 475 billion km^3

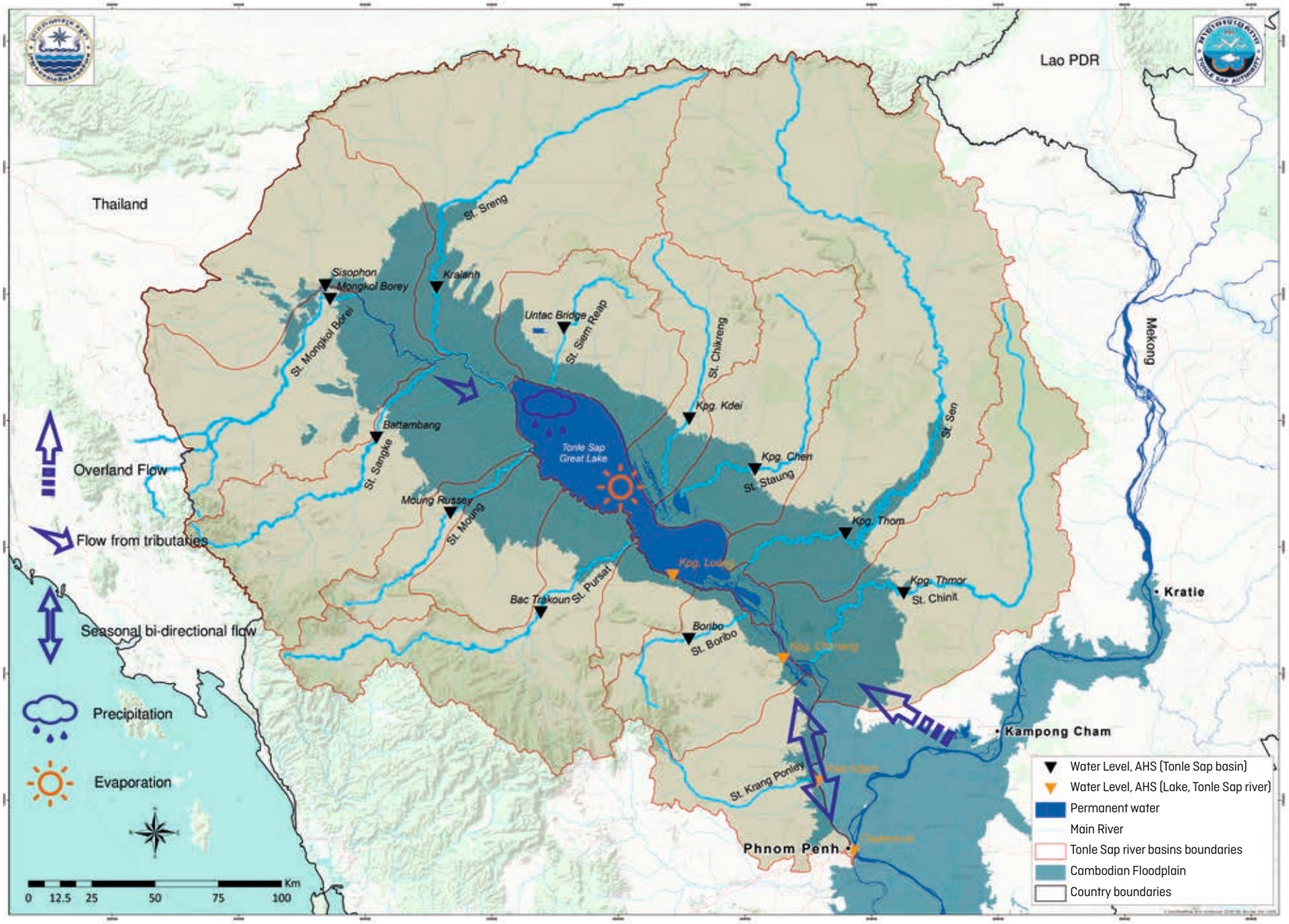
SOURCE: VIETNAM NATIONAL MEKONG COMMITTEE, 2009

Tonle Sap in figures

(1996-2005)

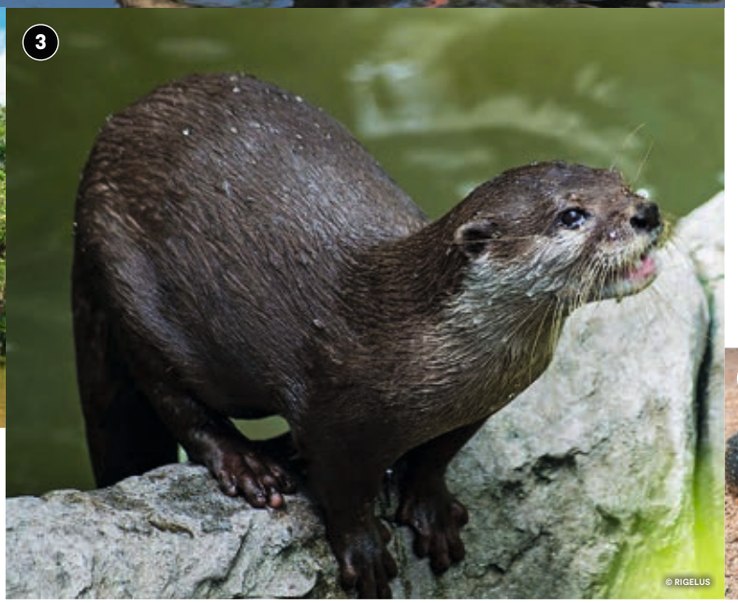
DRY SEASON		RAINY SEASON
230 to 250km²	SURFACE AREA	1,200 to 1,500km²
0.5 to 1m	DEPTH	8 to 11m
24.5km³	VOLUME	54km³

Floating village in the dry season, March 2018. © TSA



Rythm of Tonle Sap lake water balance and bi-directional flow with Mekong river

Reversal of the flow of the Tonle Sap River, an exceptional hydrological phenomenon between the great Tonle Lake Sap and the fleuve Mekong: during the rainy season, the Mekong fills the Tonle Sap lake then, that in the dry season, the flow reverses and Tonle Sap Lake flows to the Mekong. SOURCE : TSA



1. Mycteria leucocephala (Painted Stork) – 2. Barringtonia acutangula 3. Lutra sumatrana (Hairy-nosed otter) 4. Tenualosa thibaudeaui (Shad)) 5. Varanus salvator – 6. Cuora amboinensis (South Asian Box Turtle)

The flow reversal of the Tonle Sap River, from the Mekong River to the Tonle Sap Lake during the rainy season, and from the lake to the Mekong River at the start of the dry season, is an exceptional natural hydrological phenomenon seldom found elsewhere in the world, and even less so on this scale. The process generates the expansion of vast wetlands that provide a substantial refuge for the region's flora and fauna. An analysis of the water depth carried out using data from 2001 to 2018 shows that the flow reversal of the Tonle Sap River takes place from April to June at the start of the rainy season and from late September to late November at the end of the rainy season.

The Tonle Sap great lake is a living environment. Its ecosystems constitute an immense potential for fishing, natural resources, agriculture, fishing industries, tourism and navigation. The lake is recognised as a fishing industry hub and a biosphere reserve. It supplies from 60% to 75% of the country's continental fish production, or 480,000 tonnes a year. The national continental fish yield has doubled over the last 20 years, going from about 250,000 tonnes to over half a million tonnes per year, as indicated by the United Nations Food and Agriculture Organisation (FAO), which uses the total annual figures gathered by fishing adminis-

BIODIVERSITY OF TONLE SAP

167 species of fish
42 species of reptiles
225 species of birds
46 species of mammals
190 species of plants

trations in districts and provinces.The 98 floating villages around the TSGL house almost 28,000 families with a population of over 330,000 individuals.

Wetland habitats provide a refuge for communities of fish, birds, reptiles, mammals and plants.

The ecosystems in Tonle Sap Lake and its surroundings are highly vulnerable to the impact of activities developed both locally and regionally. The pressure created by the rapid growth of the population, overfishing and over-exploitation of natural resources, as well as economic development, generate threats for the entire ecosystem, and in particular affect the areas around Tonle Sap Lake.

Stung Sen River

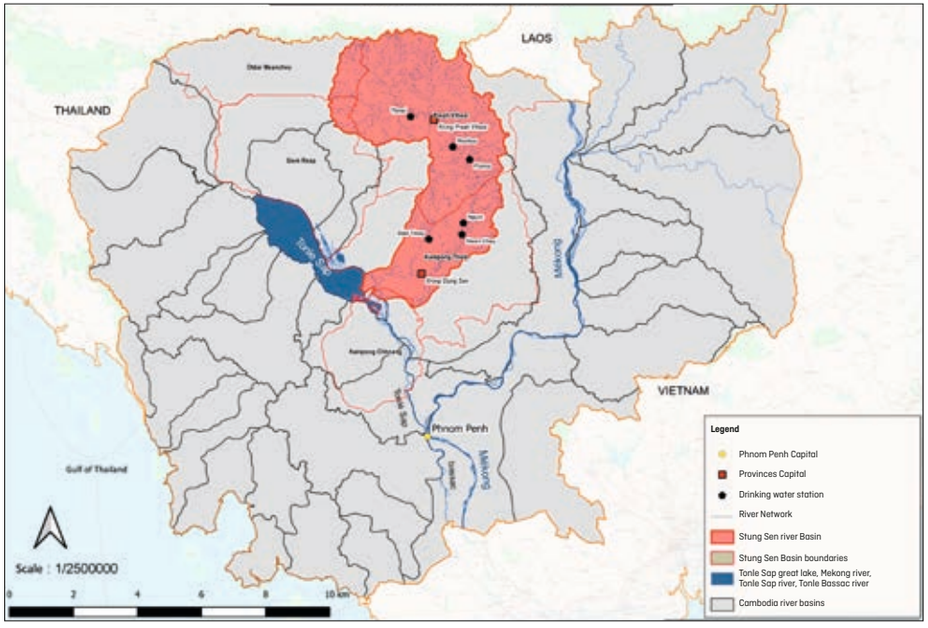
The Stung Sen River is the longest of the main 11 tributaries of Tonle Sap Lake. With its source at around 790m altitude in the Dângrêk Mountains, its total course of 520km crosses Preah Vihea province for about 264km and Kampong Thom province for 256km, ending in the Tonle Sap Lake at an altitude of 7m.

The river basin has a surface area of around 16,344km^2 and covers the two provinces of Kampong Thom and Preah Vihea and a small part of the provinces of Odar Meanchey, Siem Reap and Kampong Chnang.

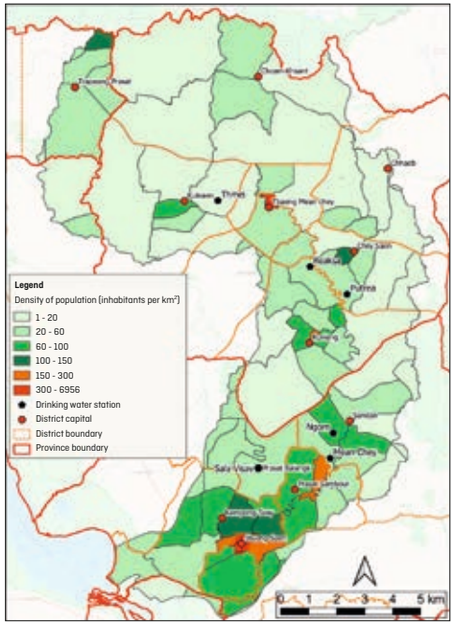
On its journey, the Stung Sen crosses the capitals of two provinces, Preah Vihea (Krong Preah Vihea: 24,360 inhabitants, 2019 census) and Kampong Thom (Krong Stung Sen: 53,088 inhabitants, 2019 census). The total population of the Stung Sen river basin in these two provinces totalled 561,251 in 2019:

- Preah Vihea province: 10,279km^2, 210,942 inhabitants – population density/km^2: 21.3
- Kampong Thom province: 4,663km^2, 350,309 inhabitants – population density/km^2: 75.1

Map of Cambodia and the Stung Sen river basin SOURCE TSA AND OIEAU



Population census and drinking water supply stations. SOURCE TSA



Basin characterisation of the Stung Sen and hydrology

Until 2022, the Stung Sen featured no hydraulic installations along its entire course. This 520km-long water course can be broken down into three different types:

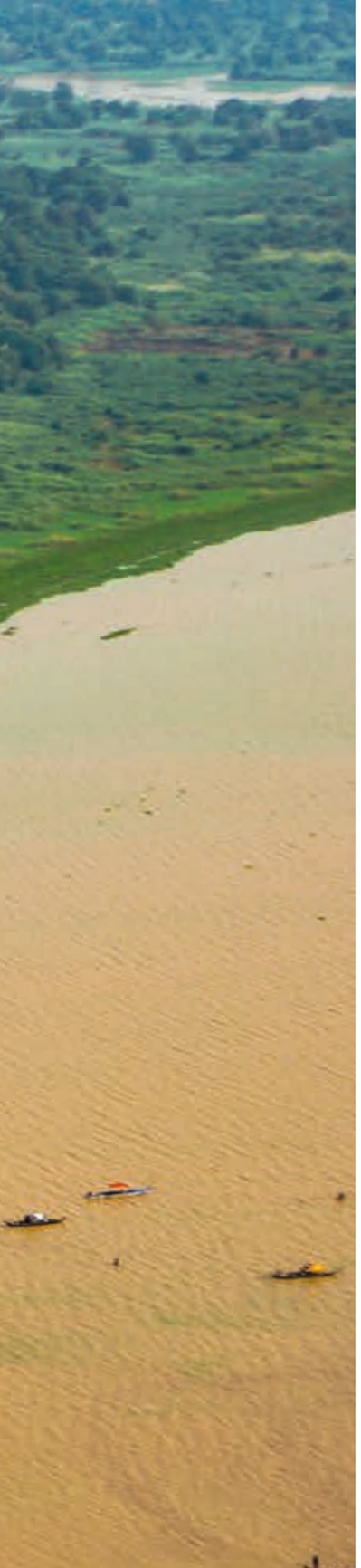
- From its source to KP (kilometre point) 400: relatively steep (1 to 2 /1,000) pre-mountain water course from 3 to 6m wide, bordered by riparian woodland comprising shrubs and pastureland.
- From KP400 to KP250: water course wider than 50m with a slope of around 1% on a sandy bed. Fairly steep banks with a corridor made up of trees and shrubs.
- From KP250 to KP0: water course with a slope of less than 1% on a moveable riverbed. It is a plain river bordered by crop fields, in particular rice paddies, and industrial food crops.

Climate

Cambodia is located in the lower part of the Mekong Basin, and has a tropical climate with two seasons: the rainy season (beginning between April and June and ending approximately between late September and late November) that receives 80-90% of the country's annual precipitation; and the dry season (approximately from November

From its source to KP400: Pre-mountain stream with a relatively steep gradient (1 to 2/1000).
© MOWRAM

From KP250 to KP0 : watercourses with a gradient less than 1% flowing.
© TSA



to April) beginning with mild temperatures and ending with high temperatures. Over recent decades, Cambodia has seen changes in seasonal weather patterns. The rainy season, which used to start between April and June and end between late September and late November, has been more variable. Precipitations are often less predictable, with late rains sometimes occuring during the dry season, or earlier rains before the start of the rainy season. These variations can impact agriculture and the water supply, pointing to the importance of sustainable water resources management to deal with the challenges of a changing climate. A climatic analysis of Cambodia[1-2] highlights the following trends:

• Average annual temperature: 25-27°C during most of the year with an average maximum temperature of 38°C in April and an average minimum temperature of 17°C in December.

• Average annual temperatures have risen by 0.8°C since 1960, which is about +0.18°C per decade.

• Average annual precipitations generally amount to between 1,400 and 2,000 millimetres (mm), with higher levels in the coastal and mountainous regions and lower quantities in the inland regions.

Inter-annual variations in the climate result from the southern oscillation *El Niño*, which influences the nature of the region's monsoons and generally brings warmer, drier winter conditions than average in South-east Asia, whereas *La Niña* brings cooler than average winter conditions.

Hydrography of the Stung Sen and its hydrology

To classify its river system, the Stung Sen basin was divided into 9 sub-basins, using the Pfafstetter method. Downstream to upstream, the sub-basins are as follows:

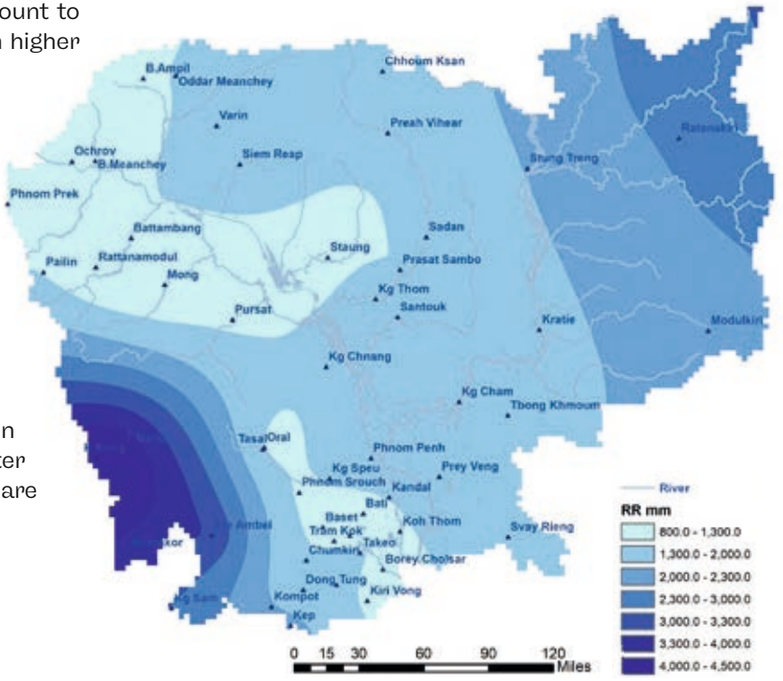
1. Downstream Stung Sen
2. Stung Kombut
3. Largest Stung Sen tributary
4. O'Ronul
5. Tbeang Meanchey
6. Stung Chenh
7. Takung
8. Stung Traloeung
9. Upstream Stung Sen

[1] KP: Kilometre point from upstream to downstream (see card p.34)
[2] WBG Climate Change Knowledge Portal (CCKP 2021). Climate Data: Historical· URL: https://climateknowledgeportal·worldbank·org/ country/cambodia/climate·data·historical

KEY FIGURES

ABOUT CLIMATE

Average annual temperature: **25-27°C**
Average maximum temperature: **38°C**
Average minimum temperature: **17°C**
0.18°C increase per decade
Average annual precipitation: **1,400-2,000 mm/year**
Climate impacted by *El Niño* and *La Niña*



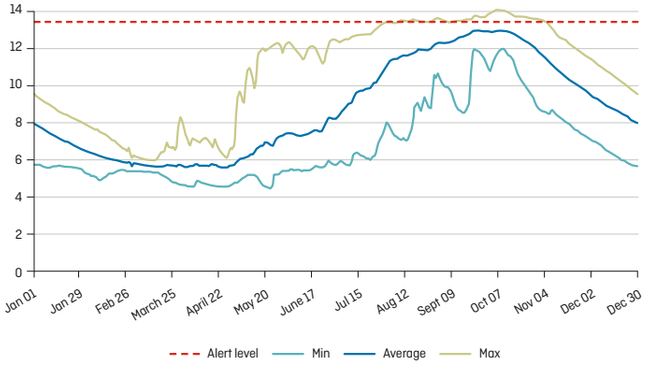
Mean rainfall distribution in 12 years.
SOURCE MOWRAM

© TSA

La You

Provincial Director of MOWRAM in Kampong Thom

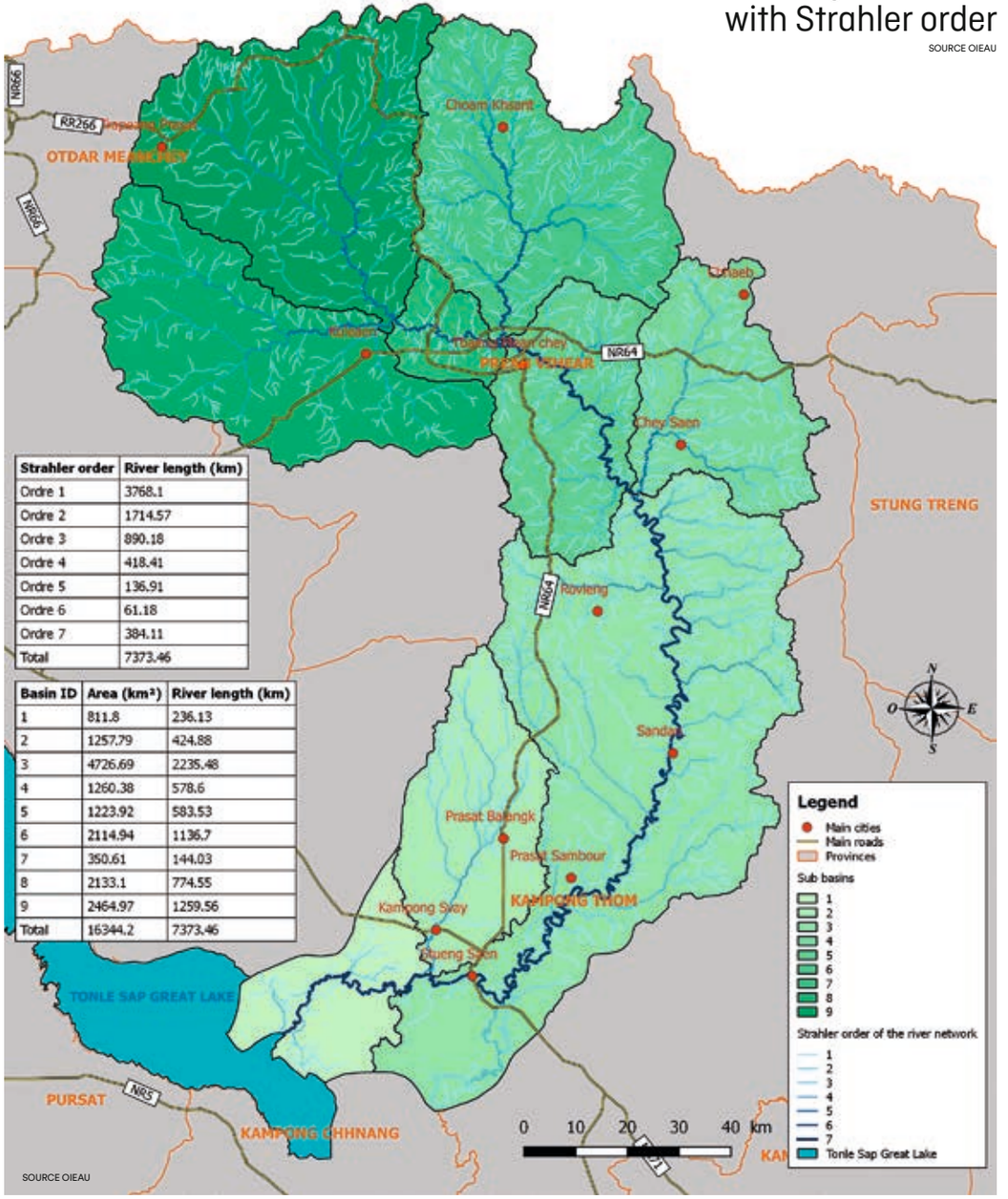
« Thanks to the data acquired in the Stung Sen project, in particular hydrology data, I am now rapidly informed of flash flood alerts. This information really helps me manage natural catastrophes like floods with local communities. In future, I would be particularly interested in an estimation of water withdrawals in the downstream section of the Stung Sen to better control the region's irrigation needs and industrial activity, and to guarantee a minimum flow in the Stung Sen. I also need more visibility on the duration of floods, which seem to be lasting longer. »



Average, maximum and minimum water depth of the Stung Sen at the Kampong Thom station (2001-2022). SOURCE OIEAU

Hydrography of the Stung Sen basin with Strahler order

SOURCE OIEAU



Strahler order	River length (km)
Ordre 1	3768.1
Ordre 2	1714.57
Ordre 3	890.18
Ordre 4	418.41
Ordre 5	136.91
Ordre 6	61.18
Ordre 7	384.11
Total	7373.46

Basin ID	Area (km²)	River length (km)
1	811.8	236.13
2	1257.79	424.88
3	4726.69	2235.48
4	1260.38	578.6
5	1223.92	583.53
6	2114.94	1136.7
7	350.61	144.03
8	2133.1	774.55
9	2464.97	1259.56
Total	16344.2	7373.46

SOURCE OIEAU

The total length of the Stung Sen river system is estimated at 7,373km, classified with the Strahler order from 1 to 7, for a total surface area of about 16,344km^2.

Like all of the rivers in Cambodia, the Stung Sen has a hydrological regime marked by two distinct periods: the rainy season, characterised by a water depth recorded at Kampong Thom station of about 13m at its peak in late September/early October (average calculated using data from 2001 to 2022); and a dry season characterised by a depth recorded at Kampong Thom station of about 5.6m at its lowest level in April (average calculated using data from 2001 to 2022).

At the level of the historic Kampong Thom station for which data have been available since 1982, extreme values (max and min) were observed in 2021 and 2022:

• In October 2022, the level of the Stung Sen reached 14.08 m at Kampong Thom, corresponding to the highest value since records began in 1982, considering that the alert at Kampong Thom is set at 13.5 m.

• In May 2021, the level of the Stung Sen dropped to 4.8 m at Kampong Thom, corresponding to the lowest value recorded since 1982.

▲ May 2021. At Kampong Thom, the Stung Sen drops to 4.8m.
◀ In October 2022, it reaches 14.08m. © MOWRAM-TSA

Knowledge of surface waters: quantity and quality

At the start of the project, only one automatic hydrological station was located on the Stung Sen basin, the HYCOS station in Kampong Thom, which has recorded daily water levels of the Stung Sen since 1982.

Since 2016, five automatic hydrological stations (AHS) (three in Preah Vihea province and two in Kampong Thom province) and seven automatic weather stations (AWS) (three in Preah Vihea province and four in Kampong Thom province) have been installed in the Stung Sen river basin. They provide daily data on water depth, pluviometry, and other meteorological parameters.

In 2020, seven campaigns to measure the flow of the Stung Sen River were carried out with an acoustic doppler current profiler (ADCP) at four points along the Stung Sen, in order to establish a water depth / flow ratio for the different periods. As an example, at the Kampong Thom Bridge, the river height H = 8m corresponds to the measured flow Q = 900m³/s.

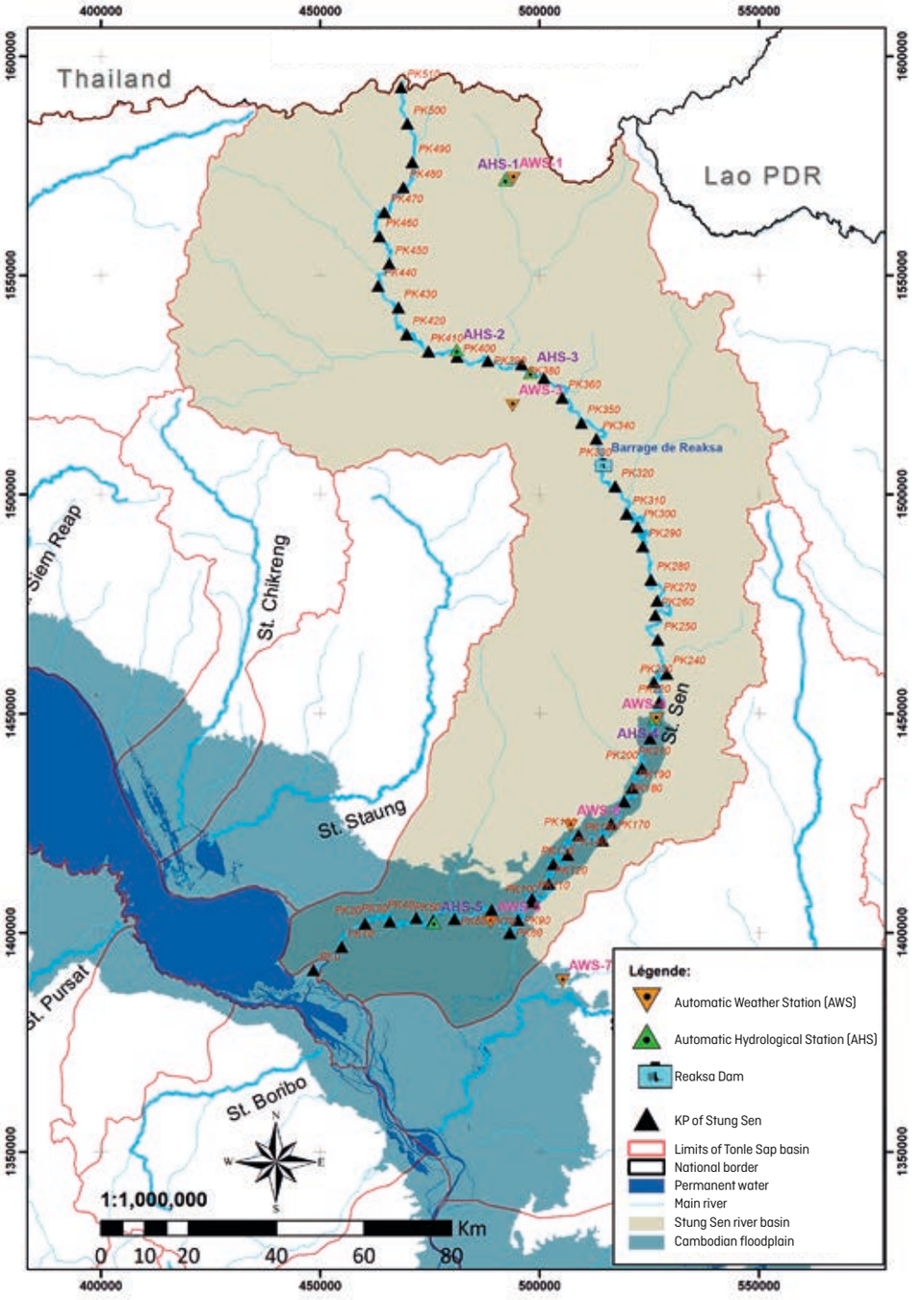
From the start of the project in 2013, regular monitoring of water quality has been carried out twice a year (March in the dry season and September in the rainy season) at four stations along the Stung Sen by the TSA with support from MOWRAM to carry out laboratory analyses. Concretely, withdrawals are made by the TSA team and the samples are sent to the MOWRAM laboratory approved by the Mekong River Commission (MRC), in Phnom Penh.

The selected parameters and withdrawal techniques are in compliance with the recommendations of the Mekong River Commission. The work involved training agents on these techniques, partly through short courses specially organised in English at the French National Training Centre for Water Professionals (CNFME) in France.

Since 2016, regular monitoring has been carried out with withdrawals at the level of the five AHS stations set up along the Stung Sen River, and at the mouth of the Stung Sen on the Tonle Sap Lake at Phat Sanday. In total, 20 physico-chemical parameters and two bacteriological parameters are analysed at the MRC-approved MOWRAM laboratory, four times a year. The quality of surface water is generally good with a few exceptional parameters, such as matter in suspension, iron and faecal coliforms.

Longitudinal profile of the Stung Sen

SOURCE TSA



Since 2016, samples have been taken regularly at five automatic hydrological stations installed along the Stung Sen and at the mouth of the Tonle Sap lake at Phat Sanday. © TSA

In addition, pesticides, particularly organochlorine insecticides and fungicides, have been detected in surface waters, most of which come from phytosanitary treatments employed in agriculture, with a greater concentration for sugar cane crops. This presence of pesticides in surface waters raises serious concerns in terms of water quality and environmental protection, calling for responsible management and appropriate measures to minimise the impacts on aquatic ecosystems and public health. In 2021, the Chinese companies that operated the sugar cane plantations from 2018 to 2020 stopped their activities. Withdrawals and analyses scheduled for 2023 will show whether the concentrations of pesticides detected in 2019 have remained or dissipated.

In terms of budget, the TSA has financed all of these withdrawal campaigns and analyses.

N.B.: Concerning groundwater, the data currently available are limited, but initial analyses indicate good water quality. Nevertheless, it is imperative to carry out additional studies to strengthen our hydrogeological knowledge and better understand the interactions between water tables and water courses. In addition, a surveillance network should be set up to regularly measure the quality of groundwater, in particular at the level of existing stations and those being developed. This network should also monitor the piezometric level of water tables, improving the precision of monitoring and management of groundwater.

Land use

Located in a fast-developing country, the Stung Sen is changing rapidly, with vegetation cover being replaced by agriculture over the years, as shown by the maps of land use evolution from 2000 to 2018, produced using data from the Landsat 8 satellite.

During the period from 2000 to 2018, forest cover shrank by 41% (from 13,679km^2 to 8,013km^2), which represents a change of almost 35% of the total surface area of the river basin. In parallel, the cultivated surface area increased by 351% (from 833km^2 to 3,757km^2), concerning almost 18% of the basin's total surface area.

On the entire Stung Sen river basin, from 2000 to 2018: 3,595km^2 (26%) and 2,125km^2 (16%) of forest cover were converted into undergrowth and cultivated land respectively. The "other forests" category saw a significant increase of 117% compared to its initial state (from 55km^2 to 120km^2). This change can be explained by the progression of rubber tree plantations within forested areas.

"Artificial surfaces" saw a 62% rise, with the surface area increasing from 113km² to 184km². The phenomenon of artificialisation related to recent urbanisation is particularly apparent in Preah Vihea province.

The considerable change in land use impacts water quality and quantity, necessitating adapted measures to limit this degradation, notably by targeting the biggest pressures such as agricultural diffuse pollution and increased runoff. It is important to measure these impacts and act in accordance to preserve water resources.

KEY FIGURES

LAND USE CHANGE (FROM 2000 TO 2018)

3,595km² (26%) and 2,125km² (16%) of forest cover have been converted into "undergrowth" and "cultivated land" respectively

929km² (58%) of "undergrowth" have been transformed into "agricultural areas"

Increase from 55km² to **120km²** of the "other forests" category (117%)

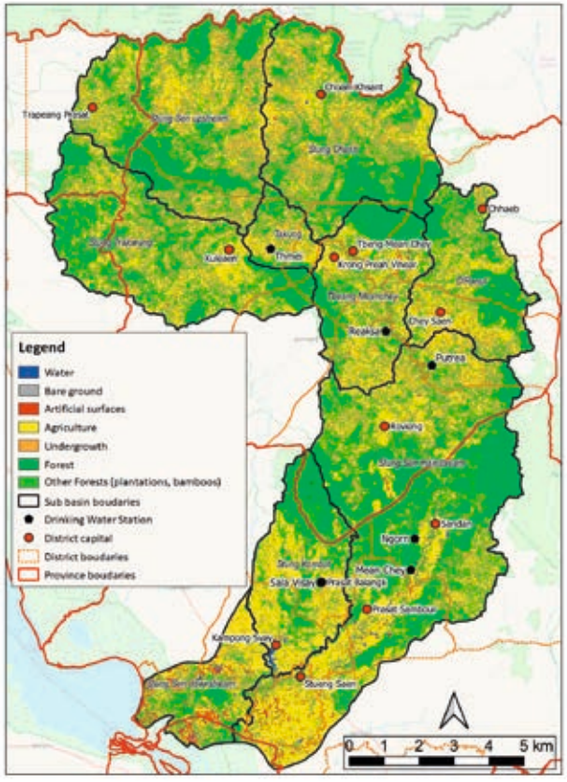
Increase from 113km² to **184km²** of the "artificial surface areas" category (62%)

Land use maps in the Stung Sen watershed

SOURCE TSA

for the year 2000

for the year 2018



Water uses

The main water uses identified in the Stung Sen river basin are domestic (drinking water, hygiene, food, etc.), agricultural (rice, cashew nuts, bananas, rubber, corn, etc.), and industrial.

Inhabitants of rural areas in Cambodia regularly withdraw water for their domestic usage from three sources: surface water when accessible; groundwater, requiring suitable equipment; and rainwater, which is only available a few months of the year.

Given the fast development in the country, agricultural areas have expanded considerably over the last 20 years. A multiplication of the number of rice-production cycles per year puts strong pressure on water resources during the dry season.

Given that surface water is the main source of irrigation in the Stung Sen basin, either directly withdrawn from the river or stored in private reservoirs, it is crucial to establish appropriate planning and management to avoid conflicts related to using this water.

Domestic use and drinking water

From 2019 to 2021, surveys were carried out in Kampong Thom and Preah Vihea provinces to evaluate water uses and access to drinking water in the Stung Sen basin.

These surveys, carried out in most rural municipalities along the Stung Sen, led to an inventory of the sanitation systems and wells, and the drinking water treatment plants and their operations.

The surveys covered 12 districts and 60 municipalities totalling 439 villages and 404,272 inhabitants, or 84.5% of all of the municipalities in the basin and 89% of the villages.

The remaining municipalities were not questioned since they are located in city centres (Kampong Thom and Preah Vihea), where water treatment plants and the supply network are managed by water boards.

Dry Season Water Access Conditions in Putrea Village, Preah Vihea Province, Stung Sen River Basin, May 2015. © OIEAU

Storage room for drinking water canisters at Putrea station, financed by French cooperation. © TSA

Between 2019 and 2021, surveys were carried out in the provinces Kampong Thom and Preah Vihea provinces to assess water and access to drinking water in the Stung Sen basin.
© OIEAU

The inventory of these drinking water and sanitation facilities and their usage allowed the team to:

• understand the situation of inhabitants concerning access to drinking water and identify the different existing technical and financial supports to install water treatment and supply facilities in beneficiary municipalities and villages, including in schools, clinics, pagodas, etc.;

• understand the situation of inhabitants concerning access to water for domestic usage, identify the main water sources used by inhabitants and other users, and understand the situation of inhabitants and existing support in terms of access to sanitation in rural areas.

Drinking water access

Access to drinking water in rural areas of Preah Vihea province and Kampong Thom district was very limited until 2015. Apart from a private drinking water treatment plant in Preah Vihea, there was practically no other collective infrastructure available. In the centre of Kampong Thom district, a few private water treatment plants were in operation, and the city of Kampong Thom was supplied with water by a water board.

To deal with the issue, starting from 2016, socially responsible projects were implemented with financial support from the French water agencies, leading to a significant improvement in drinking water access in the Stung Sen basin, with a particular focus on equipping schools and health clinics. During the period, which lasted until 2020, seven plants were built thanks to this collaboration. However, it is important to note that these plants came up against several operating difficulties, explained in detail in Chapter 4.

These technical and administrative challenges highlight the need to adopt a global, sustainable approach when setting up projects aimed at improving access to drinking water. It is imperative to take diverse aspects into consideration, such as the needs and expectations of inhabitants, technical aspects like maintenance and water supply, and administrative considerations related to managing finances.

These points of vigilance guarantee the smooth operation and sustainability of drinking water facilities within rural communities.

The survey of populations living along the Stung Sen identified existing support for access to drinking water in these municipalities along with the technical and administrative management systems in place to ensure their longevity.

Support identified for access to drinking water

Of the 60 municipalities questioned in the 2019-2021 survey, 21 had already received support from a number of organisations/institutions to establish drinking water systems (including World Vision, 1001 Fontaines, Lien Aid, World Fish and other NGOs) and five private companies had set up facilities (Bak Hong Company, Sen Sokunthea Company, Soum Vuthy Company, Leang Iounny Company and Ouch Veng Company).

In the Stung Sen river basin, three types of support in the clean water and sanitation sector can be distinguished:

• Government support

At national level, several actors, including the Ministry of Rural Development, the Red Cross, and the municipal fund, support projects to facilitate access to drinking water and sanitation. The key measures include digging wells and

Hand-washing (sanitary) facilities in schools, financed by French cooperation.
© TSA

Tank for storing clean water in rural communities, financed by the Asian Development Bank (ADB).
© TSA

building sanitary facilities, such as toilets, which significantly improve living conditions for rural communities.

• Support from donors and bilateral projects

Support comes from the Asian Development Bank (ADB), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), UNICEF, and the French Rhin-Meuse and Loire-Bretagne water agencies.

The support provided by water agencies is unusual because it comprises two parts: institutional support devoted to implementing IWRM, and support for socially responsible projects devoted to developing drinking water facilities.

Since 2016, this French support has been active in the Stung Sen basin, where nine water treatment plants have been built, involving works amounting to €2.05M including almost €1.6M of financial support. The photos below show one of the nine clean water stations financed by the water agencies and one station financed by the ADB.

• Associations

Financial support comes from Cambodian and international associations (AUSTRALIA, Catholic, ISLAM, JAPAN, KOREA, KHMER) and mainly targets drinking water facilities with low production capacities using pre-treated water (1 to 2m³/day). The drinking water is sold in 20-litre canisters costing about 1,500 to 2,000 Riels/canister (USD 0.375 to 0.5/canister).

Wells and toilets are also installed in villages and schools.

Private companies are also present in the two provinces to supply drinking water. They number five in Preah Vihea province and one in Kampong Thom province. Little information is available concerning water sources, treatment methods, production and supply capacities. This information could be obtained in a future complementary survey.

The surveys have shown that municipalities have benefited from several types of infrastructure through these different financiers (donors, associations, government aid):

- drinking water plants, mostly without a supply network (25%),
- artesian wells and well rings (32%),
- toilets (40%),
- schools benefitting from access to drinking water: about 13÷380,
- healthcare clinics benefitting from access to clean water: only 13÷36,
- two municipalities have no support (3%).

The municipalities benefitting from this equipment are shown on the map below.

Typical treatment station for drinking water in the basin of Stung Sen, financed by French cooperation.
© OIEAU

REMINDER

Districts and municipalities located along the Stung Sen in the two provinces (Preah Vihea and Kampong Thom) total

13 districts, 71 municipalities, 492 villages

These investments contribute to strengthening basic infrastructures, improving public health, and reducing poverty by making it easier to access essential resources like drinking water and sanitary facilities.

It is also important to underline the importance of a coordinated approach and partnerships between government actors, non-governmental organisations and local communities to ensure the effective, sustainable implementation of these projects. Collaboration and coordination between these different stakeholders is essential to maximise the impact of investments and ensure the longevity of the infrastructures set up.

Continuing needs

It is encouraging to note that the mindset of inhabitants has evolved over the last few years, including a greater awareness of the health risks related to consuming non-potable water. The demands and needs identified by the survey reflect the growing aspirations of inhabitants in terms of access to drinking water. Below is an analysis of the items raised to respond to these demands:

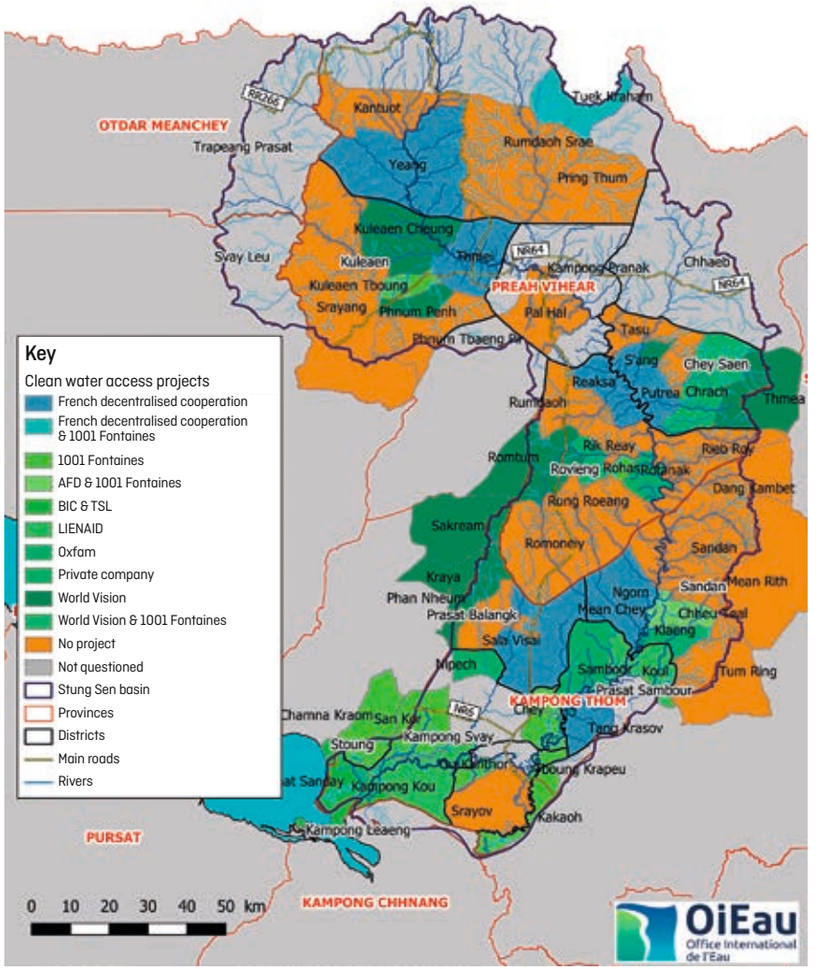
• Individual connection to the water supply:
The installation of a drinking water supply system with individual meters would allow inhabitants and shops to directly access drinking water. This calls for efficient management of the supply system and technical training to ensure its smooth operation and maintenance.

• Development of supply systems and standpipes accessible to the population

• Home delivery of drinking water canisters:
Home deliveries of 20-litre canisters of drinking water are a practical solution for people not connected to the system. It requires well-organised logistics, including suitable vehicles and employees for the distribution.

• Installation of drinking water tanks in remote villages/hamlets:
For remote areas where connection to the water supply system is difficult, installing 1-cubic-metre water tanks can be an affordable solution. This calls for careful planning of the placement of tanks, and water supply management and maintenance.

• Installation of drinking water tanks in schools and dispensaries:
Ensuring access to drinking water in schools and health clinics is essential to promote health and safety.



Projects for access to clean water in municipalities on the Sung Sen basin

Map showing municipalities benefiting from support to access drinking water in the Stung Sen river basin (2019-2020 surveys). SOURCE OIEAU

Installation of small "Safe Water Cube" drinking water treatment plants in schools in the floating villages of Tonle Sap Lake. Decentralized action supported by the Loire-Bretagne Water Agency, 2019. © TSA

• Equipping municipalities without access to drinking water:
The areas identified on the map as not yet benefiting from access to drinking water require particular attention. It is crucial to develop adapted solutions in these areas, taking local resources into account.

The issues related to these demands include managing installations (public or public/private), financing the supply network, and the need to generate income to ensure the operation and maintenance of the system. It is important to guarantee profitability between the quantity of drinking water produced, its distribution, and its sale, in order to guarantee the system's financial sustainability.

Lastly, the logistics of water supply in these remote areas call for appropriate means like adapted vehicles and trained staff to successfully reach these distant communities.

Resolving these challenges calls for a comprehensive approach, involving partnership between local authorities, non-governmental organisations and private players to ensure effective management, sustainable financing, and the successful implementation of solutions for accessing drinking water.

Concretely, this translates into the following focus points:

1. Public or public/private management of installations and technical training

- Public management of installations involves an approach centred on the public interest.
- A public/private collaboration can also be envisaged, thus drawing on the expertise and resources of the private sector while maintaining public supervision.
- Technical training is essential to guarantee that the personnel responsible for managing the installations possess the competencies required to maintain and repair equipment, ensure an efficient water supply, and guarantee the quality of drinking water.

2. Financing of the water supply system and financial returns

- The financing of the supply system can come from different sources such as public funds, subsidies, public/private partnerships or loans.
- It is important to develop a viable financial model, with reasonable water tariffs for connected users, along with management mechanisms that generate revenues to ensure the system's sustainability.
- Financial income can come from selling drinking water, additional services like maintenance of water meters, or commercial partnerships.

3. Profitability between the quantity of drinking water produced, its supply, and sales

- Careful planning of the drinking water production capacity is necessary to meet demand while avoiding excessive losses.
- Appropriate pricing mechanisms should be put in place to cover the costs of production, distribution and maintenance, while remaining affordable for users.

- A reflection has been underway since the creation of the Stung Sen Basin Water Association to pool services on water, sanitation and hygiene at a pertinent scale in order to reduce running costs and optimise expenditure on operations and maintenance.
- Regular monitoring of the quantity of water produced, distributed and sold can inspire trust in users and optimise the system to ensure its profitability.

4. Supply logistics for remote areas

- Identifying remote villages/hamlets requiring drinking water supply is crucial to plan delivery routes and appropriate means of transport.
- The use of vehicles suited to local conditions, such as tanker lorries, is essential to transport drinking water safely and efficiently.
- It may be necessary to recruit and train local staff to distribute water, and to maintain facilities in remote areas.

It is important to underline that resolving these challenges calls for a collaborative approach involving local authorities, associations, the private sector, the Stung Sen River Basin Committee and its commissions (drinking water working group) and the communities themselves. The active participation of stakeholders and concerted planning are essential to guarantee the success of projects for access to drinking water and ensure their long-term existence.

With this target in mind, a drinking water working group was set up under the aegis of the Stung Sen Basin Committee.

Domestic water usage and access to sanitation

Inhabitants of rural areas in Cambodia are used to withdrawing water for their domestic usage from three sources: surface water, ground water, and rainwater.

Surface water is not always available and rainwater is only available several months a year, with the result that support to improve access to water for domestic usage among rural populations mainly targets the construction of wells.

In 37 of the 61 municipalities questioned in the survey, a great number of associations and governmental institutions have set up projects to support the conception and construction of wells. These include: Rural Development Department, Cambodian Red Cross, Korean International Cooperation Agency, the Islamic Community, the Missionary Association, Evangelism, International Development Enterprises (IDE), World Vision, Cambodian Organisation for Women Support (COWS), Adventist Development and Relief Agency (ADRA), Deutsche Gesellschaft für Internationale Zusammenarbeit (GiZ), Asian Development Bank (ADB), Development Partnership in Action (DPA), UNICEF, Church World Service (CWS), International Schools (AH) and Chain.

Concerning sanitation, 37 of the 61 municipalities have received support from associations and governmental, non-governmental and international institutions for projects supporting the construction of latrines. These organisations are the following: Département du Développement Rural, Rhin-Meuse Water Agency (AERM), Cambodian Red Cross, International Development Enterprises (iDE), World Vision, Cambodian Organisation for Women Support (COWS), Adventist Development and Relief Agency (ADRA), Deutsche Gesellschaft für Internationale Zusammenarbeit (GiZ), Agence Française de Développement (AFD), Development Partnership in Action (DPA), 1001 Fontaines, Church World Service (CWS), International Schools (AH) and CARITAS.

© OIEAU

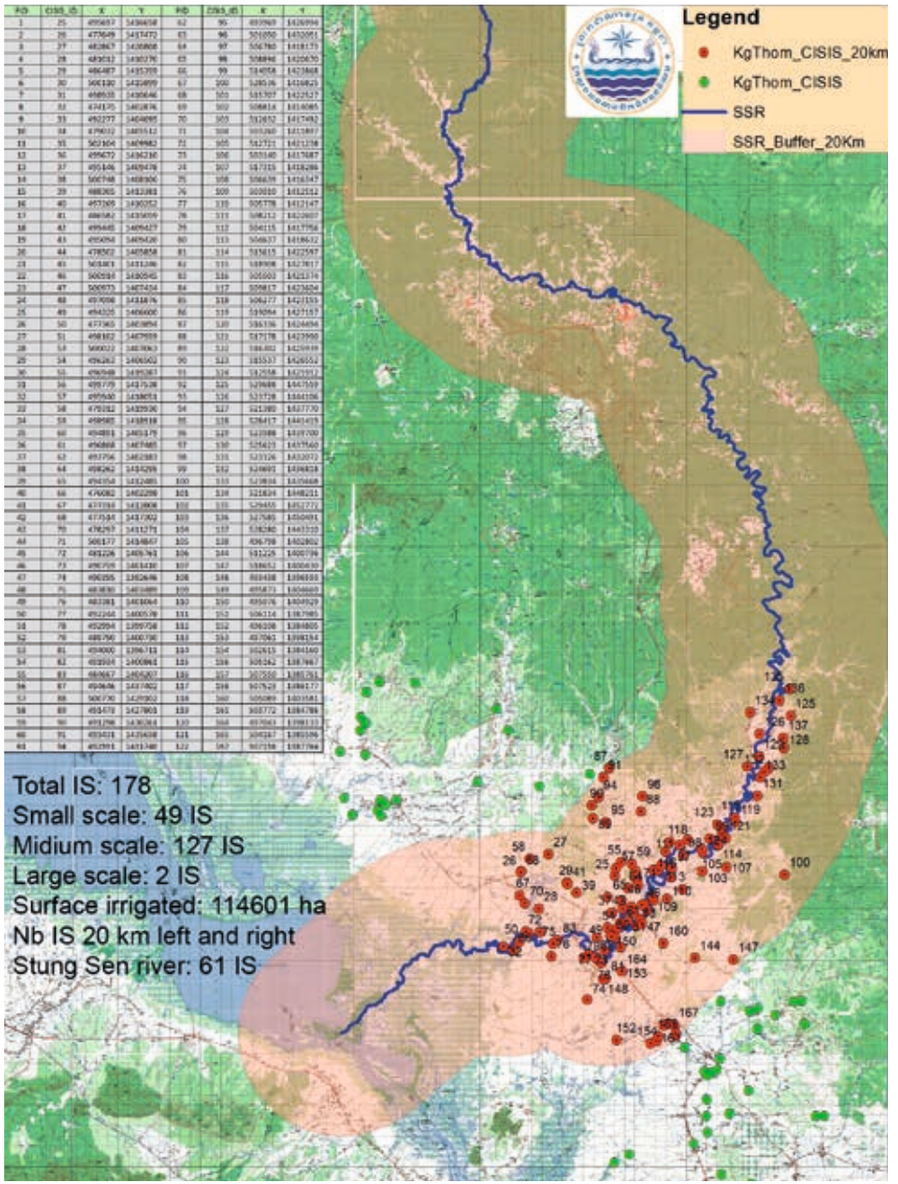
Yani Y

Manager of the Dam 95 irrigators' association in Preah Vihea

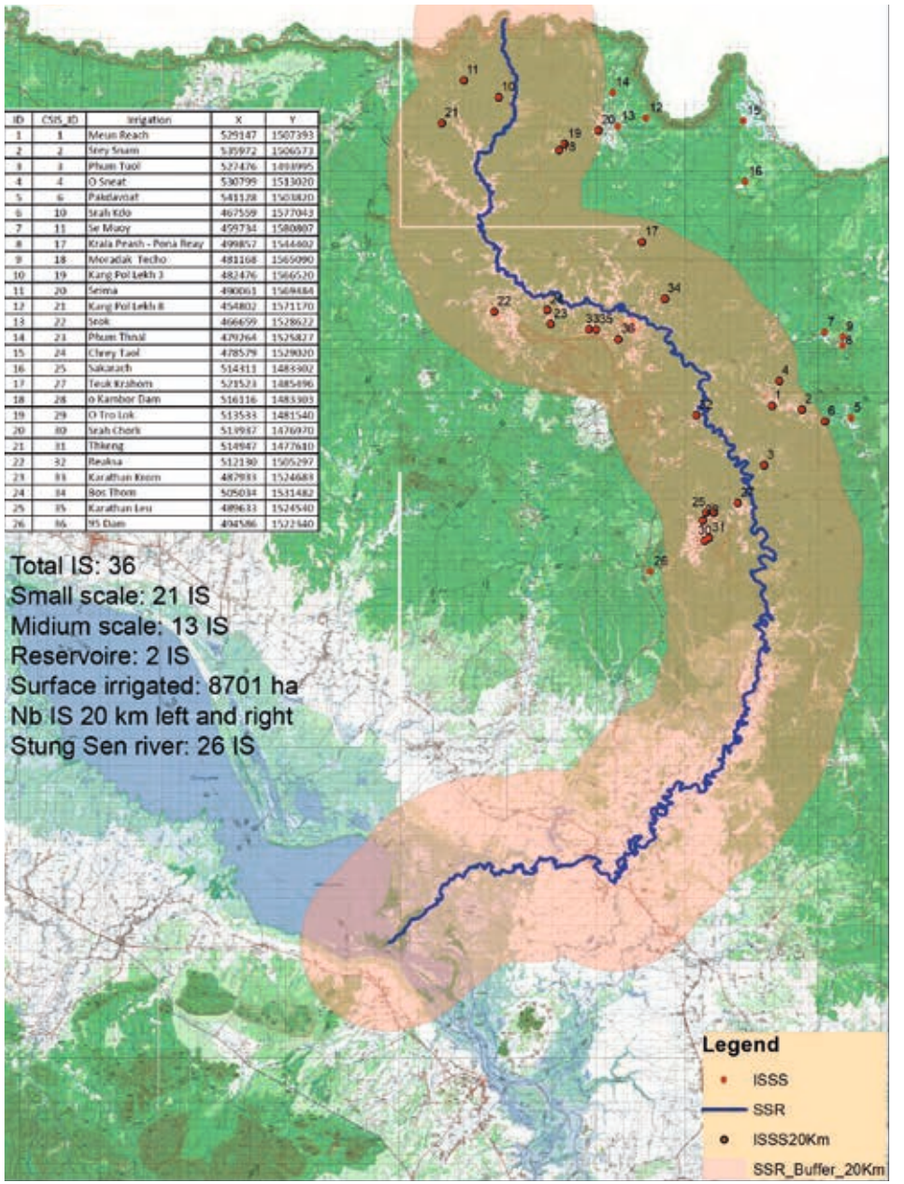
« The Stung Sen project has improved our knowledge of the irrigation scheme so that we can prioritise works. In my sector, the irrigation network is now fully built, which means we can irrigate all of the parcels and increase our rice yield. Nevertheless, we have to deal with increasingly frequent floods during the rice flowering season which impacts harvests. In future, we would like to receive training on the technical aspects of rice-growing and more efficient ways to manage irrigation systems, and on how to manage invasive plants. »

Domestic Water Use on the Stung Sen River, 2014.
© TSA

Irrigation system in Kompong Thom Province.
SOURCE : CISIS MOWRAM 2020



Irrigation system in Reah Vihear Province.
SOURCE : CISIS MOWRAM 2020



ID	CSIS_ID	Irrigation	X	Y
1	1	Meun Reach	529147	1507393
2	2	Srey Snam	535972	1506573
3	3	Phum Tuol	527476	1498995
4	4	O Sneat	530799	1513020
5	6	Pakdavoat	541128	1503830
6	10	Srah Kdo	467559	1577043
7	11	Se Mony	459734	1580807
8	17	Krala Peach - Pona Reay	499857	1544602
9	18	Moradak Techo	481168	1565090
10	19	Kang Pol Lekh 3	482476	1566520
11	20	Seima	490061	1569484
12	21	Kang Pol Lekh II	454802	1571170
13	22	Seak	466659	1528622
14	23	Phum Thnal	479264	1526827
15	24	Chrey Taol	478579	1529030
16	25	Sakatach	514413	1486902
17	27	Teuk Krahom	525523	1485496
18	28	o Kambor Dam	516316	1483303
19	29	O Tro Lok	513533	1481540
20	30	Srah Chork	519987	1476970
21	31	Thkeng	514947	1477610
22	32	Reaksa	512190	1505297
23	33	Karathan Krom	487933	1524683
24	34	Boc Thom	505034	1531482
25	35	Karathan Leu	489633	1524540
26	36	35 Dam	494586	1522540

Agricultural use

To improve the management of water for irrigation, MOWRAM identified irrigation systems to be modernised and restored at national level.

As part of this project, and with support from the AFD, activities were implemented to support the initiative, which involved the production of land parcel maps of the irrigated network along a 20km corridor bordering the Stung Sen. In parallel, activities to train the communities of irrigators (FWUCs) in charge of managing these irrigation systems were organised to improve their knowledge of water management and sharing for irrigation.

Irrigation networks mainly serve to water rice paddies on the Stung Sen river basin, and river water is also withdrawn to irrigate agro-industrial crops during the dry season such as cane sugar, mangoes, and cashew nuts, in particular in Preah Vihea province.

Lastly, a new dam was inaugurated at Reaksa in December 2022, capable of storing 259 million cubic metres of water.

Industrial use

Throughout its course of about 520km, the Stung Sen crosses two provinces, Preah Vihea and Kampong Thom. These mostly agricultural provinces feature only a few water-consuming industries that are located close to the two provincial capitals. The surveys carried out from 2018 to 2020 identified the following:

• In Preah Vihea: iron mines, a cane sugar factory that operated from 2018 to 2020, small processing units for agro-industrial produce (cashew nuts), a plant producing drinking water, and two ice plants.

• In Kampong Thom: factories processing agro-industrial produce, the Kampong Thom water board, a plant producing drinking water, an ice plant, vehicle-washing stations and ready-mixed concrete plants.

The water employed is directly pumped either from the river or from the water table. The factories are not equipped with meters, meaning that there is no information on the volumes withdrawn. The risk of industrial pollution and especially chemical pollution in the Stung Sen river basin is almost nil.

SUMMARY / CHAPTER 2

INTEGRATED WATER RESOURCES MANAGEMENT IN THE STUN SEN RIVER BASIN: STATE OF PLAY AND CHALLENGES AHEAD

Since 2012, the Cambodian Ministry of Water Resources and Meteorology (MOWRAM) and the Tonle Sap Authority (TSA) have been investigating building knowledge of this natural territory, the first stage of an integrated water resources management project.

→ Tonle Sap Grand Lake (TSGL) and its floodplain located in the heart of Cambodia form the largest natural freshwater environment in Southeast Asia, creating a refuge for exceptional biodiversity, and classed as a biosphere reserve by UNESCO.

→ The 520km-long Stung Sen River is the main tributary of Tonle Sap Lake, and crosses Preah Vihea and Kampong Thom provinces before emptying into Tonle Sap Grand Lake.

→ Following a phase of bibliographic research, in-depth field studies and the installation of five automatic hydrological stations, a diagnostic inventory and a cartographic atlas of the basin were drawn up.

→ The results showed that the quality of surface water is satisfactory, despite the presence of pesticides, thanks to regular monitoring of 22 physicochemical and bacteriological parameters and searches for 4 heavy metals. The groundwater quality is good, but requires greater monitoring.

→ The hydrological regime of the Stung Sen is characterised by very significant variations in flow depending on the season, with a severe risk of low water in April that can impact usage. Until 2022, the Stung Sen was a natural watercourse featuring no hydraulic facilities. Since then, the Reaska Dam has been opened on the upstream part of the river (operating since 2022 with a storage capacity of about 259 million cubic metres).

→ In rural areas, fewer than 20% of inhabitants have access to quality drinking water supplied by a public system. Households obtain drinking water from multiple sources and the quality of water for consumption can be problematic. However, the quality of groundwater remains good.

→ As a result of climate change and the country's economic development, several consequences exacerbate pressure on water: the spectacular reduction of forest cover due to deforestation to make way for agro-industrial crops (rubber, sugar cane, cashew nuts, mangoes, bananas, cassava) over 15 years, leading to an increase in diffuse pollution from agriculture; an increase in water withdrawals and irrigated surface areas; and more frequent flooding and droughts that are more acute and widespread impacting inhabitants and farmers.

→ Thanks to this in-depth work, the challenges facing the basin were defined participatively, forming the second stage of the project.

INSTITUTIONAL FRAMEWORK AND BASIN COMMITTEE

CHAPTER 3

The basin committee: guardian of the future of Stung Sen's water resources. Central pillar of water governance, this committee develops a concerted approach to meet environmental and socio-economic challenges. Its long-term commitment demonstrates a strong determination to ensure the sustainability of water resources and the well-being of local communities. ●

Meeting of the Stung Sen Basin Commitee for the renewal of its 21-member Steering Commitee on December 6, 2022 at the Provincial Governor's Palace from Kompong Thom.
© TSA

Governance at different scales

Water management in Cambodia is a major preoccupation and is dealt with at different scales: national, river basin, and local. At each level, measures are taken to guarantee that enough water of adequate quality is available to meet users' needs.

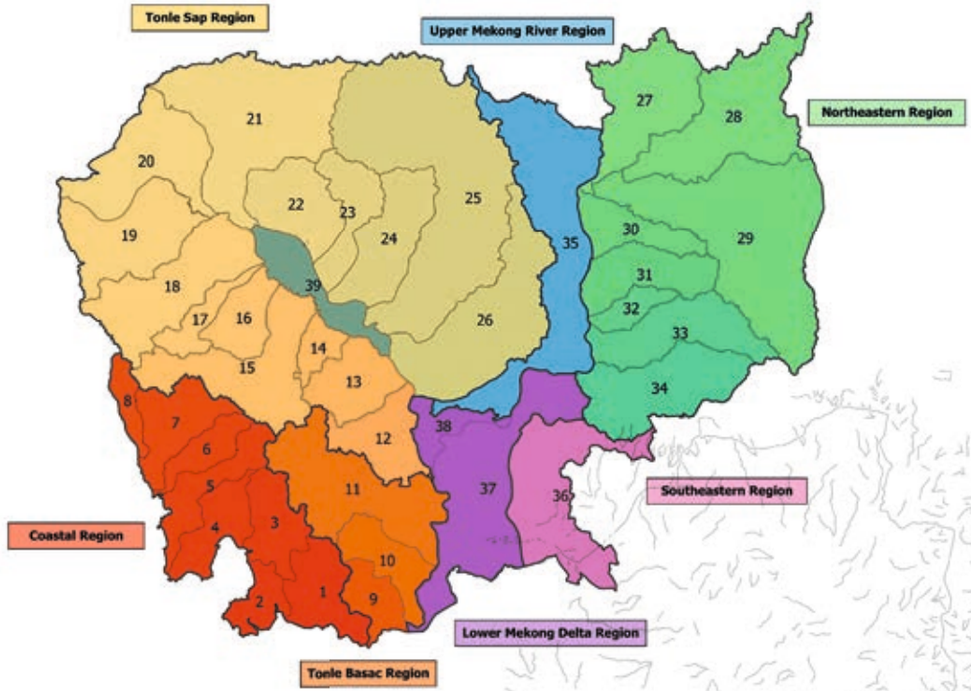
At national level, the governance of water resources management is currently being organised. A sub-decree on the management of river basins in Cambodia was signed on 24 July 2015 by the Prime Minister and divides the country into 39 river basins grouped into seven hydrographic areas: the coastal region, Bassac River region, Tonle Sap great lake region, northeast Cambodia region, Upper Mekong, southeast Cambodia region, and Lower Mekong.

To ensure optimal management of these seven hydrographic areas, a national committee to manage the river basins in Cambodia was created on 5 October 2015 following a decision by the Prime Minister. It comprises 17 members representing the different ministries and the national delegation of the Mekong River Commission. Its secretariat was established on 21 October 2015. However, to date, work has not yet started.

At basin level, the Stung Sen river basin committee was created on 25 October 2013 with the authorisation of the Minister of Water Resources and Meteorology of Cambodia, His Excellency Lim Kean Hor.

At local level, the municipalities are responsible for planning and financing investment works for drinking water, and for managing facilities like water treatment stations and water supply systems. The provincial departments of MOWRAM (Ministry of Water Resources and Meteorology) advise local authorities in this area. Farmers are also organised into associations, known as FWUCs (Farmer Water User Communities), to participate in water management.

These initiatives at different governance levels reflect the reality of IWRM in Cambodia, through the involvement of actors concerned at national, basin and local levels. Coordination and cooperation between these different entities are essential to ensure efficient, sustainable water management in the country. At each scale, governance is established and measures are taken to ensure that enough water of adequate quantity is available to meet users' needs.



Maps of Cambodia's 39 river basins grouped into seven hydrographic areas. SOURCE OIEAU

Creation of the Stung Sen River Basin Committee

In 2013, the Stung Sen River Basin Committee was initially formed with a total of 75 members, comprising 42 representatives appointed by the governor of Kampong Thom and 33 representatives appointed by the governor of Preah Vihea. Actors involved in water management are represented on the committee and divided into three groups: the state (38%), elected parties (57%) and users (5%), comprising representatives of industry, the water boards, farmers and civil society. This composition means that the different stakeholders concerned by water management in the Stung Sen basin are represented and encourages collective, concerted decision-making.

© J.L. AUBERT

Joël Pélicot

FORMER CHAIRMAN OF THE LOIRE-BRETAGNE BASIN COMMITTEE

What benefits do you see in developing institutional partnerships between the Loire-Bretagne and Rhin-Meuse basin committees and the Stung Sen basin committee in Cambodia?

– Our collaboration between the Loire-Bretagne and Rhin-Meuse basin committees and the Stung Sen basin committee illustrates the importance of institutional partnerships in the sustainable management of river basins.

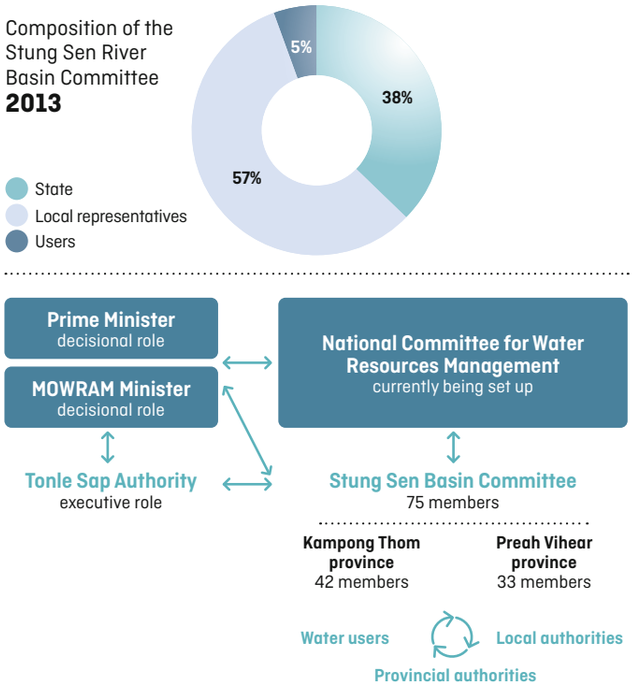
We have shared our experiences and failures, helping our Cambodian homologues to set up integrated and sustainable management of their river basin, with concrete benefits for local communities, such as access to drinking water in remote villages and schools. We have also understood how important it is for them to establish a financial contribution, even a small one, to cover the long-term management and maintenance of the drinking water supply. In exchange, we have learned from their efficient management of the flash floods and flooding that have affected one-third of their territory for centuries. We are convinced that these mutual exchanges can inspire more sustainable management of our respective basins.

What challenges must be overcome to reinforce cooperation between the basins and ensure that the actions undertaken stand the test of time?

– Our numerous exchanges have made it clear that this partnership needs to be established for the long term. It is therefore essential to strengthen the cooperation between the basins by confirming the merits of our actions on the field to the respective authorities, setting up 'water parliaments', targeting our concerted actions to meet local needs, accompanying integrated, long-term local management thanks to regular participation at local assembly meetings, and regularly raising the awareness of local decision-makers.

However, ensuring that our actions last over time is difficult, partly because of the renewal of local elected parties in the basins.

In addition, it would be beneficial for our assemblies to review our management of natural catastrophes taking inspiration from their traditional management of monsoons and droughts.



When it was created, the basin committee's main objective was to define its operating mode and share a common vision of the Stung Sen river basin and the challenges. To this end, it adopted rules of procedure and determined the issues and objectives of the Stung Sen river basin.

To support this new structure, the Tonle Sap Authority appointed a special team to play a role of secretariat and technical support. This team provides technical expertise to help the basin committee take informed decisions and put together effective strategies to manage the river basin.

The establishment of this special team shows the importance attached to managing the Stung Sun river basin and the ambition to provide specialised technical support to build the capacities of the basin committee. This technical expertise contributes to informing decisions and the implementation of effective measures for integrated water resources management in the Stung Sen basin.

The Stung Sen crossing the town of Kompong Thom highly urbanized. © TSA

Roles of the basin committee

The Stung Sen River Basin Committee's main role is to encourage integrated, participative management of water resources at river basin level. Its main responsibilities are:

• Production of a river basin management plan: the committee is responsible for developing a plan that establishes a long-term vision for managing water in the basin. This plan sets water quality and quantity targets, and establishes the strategies to implement at river basin scale. It serves as a guideline for all actions undertaken in the basin.

• Coordination of implementation of the plan: the committee facilitates coordination between all stakeholders involved in water management, such as water users, municipal representatives, provincial authorities, and the ministries concerned. It encourages participation of all stakeholders and ensures that actions defined in the plan are implemented in a consistent, coordinated manner.

• Improvement of knowledge on water resources: the committee collects and analyses data on water and the usage made of it. This can involve carrying out field surveys, measures and research in order to better understand the availability of water, user needs, and the environmental impacts related to its use.

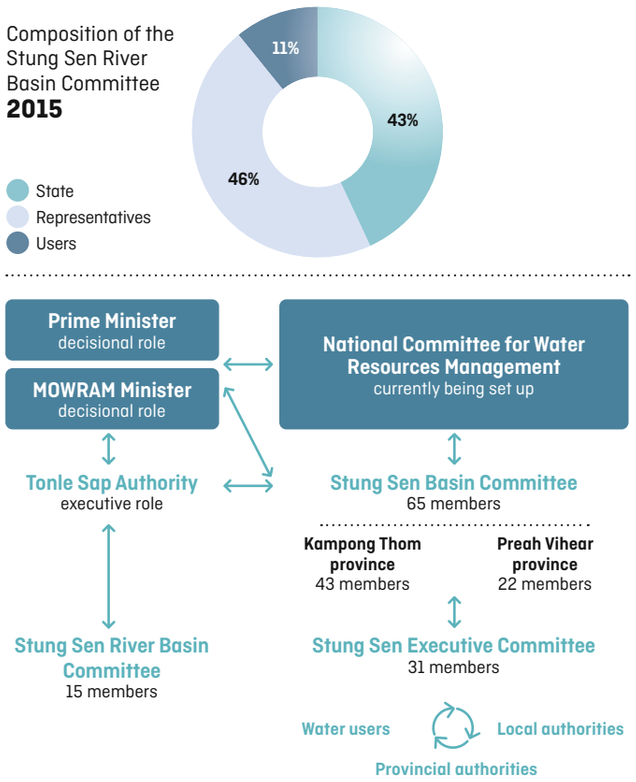
• Resolution of conflicts of usage: In case of conflicts of water usage, the committee plays an arbitration role. It facilitates negotiations between the parties concerned and suggests fair, sustainable solutions to resolve differences. The committee also oversees the respect of regulations in force and can take measures to ensure that the decisions taken are respected.

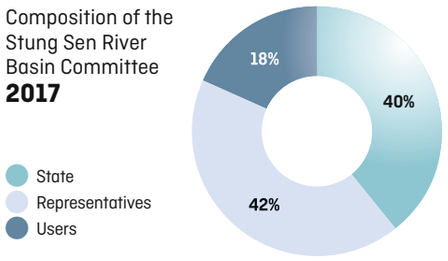
• Promotion of sustainable management of water resources: the committee encourages water management that takes into account the environmental, social and economic issues of the river basin. It encourages the adoption of sustainable practices to preserve water quality, prevent overexploitation of resources and promote fair use of water in the different activity sectors.

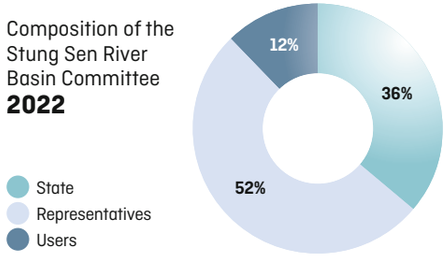
By fulfilling these responsibilities, the Stung Sen River Basin Committee contributes to more effective, balanced management of water resources, taking into account the needs and interests of all water basin stakeholders.

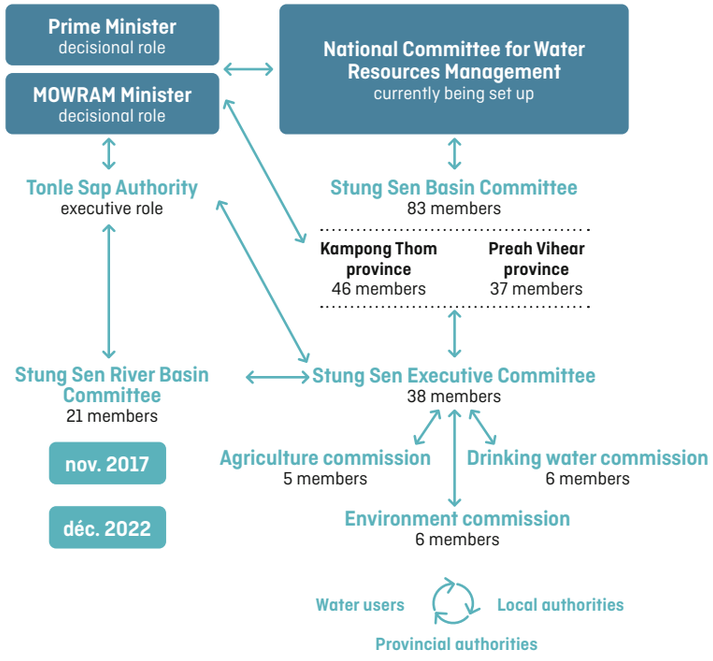
Changes to the basin committee

In 2015, after two years of operation, some significant changes were made to the composition of the Stung Sen River Basin Committee following a decision by the governor of Preah Vihea province. The number of members dropped from 32 to 22, with the aim of targeting riparian elected parties of the Stung Sen and removing those from municipalities further away from the river. The aim of this reduction was to make members more responsible and benefit from their specific knowledge of the Stung Sen. Despite the reduction, the river basin committee still comprises 65 members, divided between the three sections.









In addition, it was decided to increase the number of user representatives from four to seven, which represents 11% of the basin committee members.

An executive committee composed of 31 basin committee members was created, along with a bureau, with the aim of reinforcing the basin committee's activities. The executive committee ensures the operations of the basin committee between sessions, examines subjects under its jurisdiction, and makes suggestions to the basin committee. The bureau, comprising 15 members, is responsible for supervising and implementing the Stung Sen programme of measures and managing the administrative and financial aspects of the executive committee. The Tonle Sap Authority provides expertise and advises each of its bodies.

In 2017, two themed commissions were created: the agriculture commission and the drinking water commission. They assist the basin committee in its work and have a mission to provide recommendations on issues that come into their area of expertise. The commission members received training to guarantee similar knowledge for all members. Since their creation, the executive committee has supervised and directed the work of the themed commissions.

More recently, in December 2022, at the General Assembly of the Stung Sen River Basin Committee, the members were renewed and modifications were made to the committee's composition. The number of members in the elected parties section rose from 30 to 43. In addition, a third commission focusing on the environment was created. The bureau also expanded from 15 to 21 members, including four representatives from the farmer water user communities (FWUCs).

These successive changes in the composition and structure of the basin committee illustrate the ambition to ensure a well-balanced representation of the different stakeholders and strengthen the involvement of users in integrated management of the Stung Sen.

Following a decision by the minister of Water Resources and Meteorology, it was decided to adopt a rotating chairmanship of the Stung Sen River Basin Committee bureau,

What benefits do you see in developing institutional partnerships between the Loire-Bretagne and Rhin-Meuse basin committees and the Stung Sen basin committee in Cambodia?

– This partnership offers an occasion to share concrete experiences on the organisation and management of basins between countries looking for solutions to develop and improve integrated water resources management. Beyond practical action on the field, this institutional cooperation encourages the establishment of an organisation that I would say is sustainable and integrated into the country's way of working. It is also an opportunity to exchange on solutions implemented between the two French basins and the Stung Sen basin in Cambodia.

It is important to underline the real sanitary progress that we can bring to rural communities in Cambodia by helping them establish better access to drinking water, which significantly reduces child mortality rates. The village chief discussed this point strongly during our on-site mission.

Michel Georges

FORMER CHAIRMAN OF THE RHIN-MEUSE BASIN FINANCIAL SUPPORT COMMISSION

What challenges must be overcome to reinforce cooperation between the basins and ensure that the actions undertaken stand the test of time?

– Because the actions implemented require long-term support to secure a foothold in a fast-growing country, the stability of contact people and the continuous monitoring of actions are key to their success.

Coordination between the two French basins from the start ensured good cohesion and complementarity in relations with the Stung Sen basin, and a clear division of each agent's role. Regular updates on the state of play of the works allowed us to detect any obstacles to carrying out the action plan that we established together, and adapt to deal with the constraints and emerging needs throughout the course of the project.

Vote on measures by the Stung Sen basin executive committee. © TSA

with a change mid-term. This decision was taken following a proposal by the executive committee.

The rotating chairmanship of the bureau means that the responsibility of chairing the basin committee bureau will alternate between the governors of Kampong Thom and Preah Vihea provinces. This approach ensures fair participation of bureau members in the basin committee's decision-making and management processes.

The rotation also aims to encourage wide-ranging views, strengthen the involvement of all bureau members, and promote collegial, participative governance of the Stung Sen River Basin Committee. In addition, it guarantees continuity for activities and joint decision-making throughout the term.

Lastly, the composition of the basin committee, which has evolved over time, has continuously adapted to correspond to the reality of issues on the territory and local balances.

More than 2.6 million hectares are devoted to rice cultivation during the monsoon.
© THANATASDCOM, GETTY

Training

As part of the cooperation project, training was organised to support the members of the Stung Sen River Basin Committee in their new role, as well as the Tonle Sap Authority (TSA) team. The courses aimed to build the capacities of the basin committee to implement Integrated Water Resources Management (IWRM) in the Stung Sen river basin.

This approach of training trainers aims to ensure the sustainability of knowledge and reinforce bilateral partners' IWRM competencies and knowledge of the Stung Sen basin. The objective is to continuously build this knowledge and promote exchanges of knowhow between the various actors involved. This training approach contributes to improving understanding and effective implementation of integrated water resources management in the Stung Sen river basin.

Training for the trainers of the TSA on implementation of IWRM in the basin of Stung Sen in 2013. © TSA

In response to the needs expressed by the Tonle Sap Authority, the activities undertaken aimed to share knowledge with the stakeholders. This was done through different means, like short and long courses, seminars, workshops, and study visits.

1st phase: September 2012 – December 2014

The first phase of the project ran from September 2012 to December 2014 and established the foundations of an IWRM process in the Stung Sen pilot basin. The main activities in this phase comprised:

• Technical training in Cambodia

Training sessions were organised in Cambodia, centred on methods to carry out basin inventories and characterisations, and on participative definition of problems, challenges and objectives. This training, taught by experts from the French water agencies and OiEau, served to build the skills of the TSA team and the members of the Stung Sen River Basin Committee. They covered subjects like participative planning, institutional and legislative frameworks, identification of issues in the basin, and collecting and managing data required for IWRM.

• Institutional exchanges with French and regional partners

With the aim of encouraging sharing of experiences between French and Cambodian actors, a delegation from TSA was invited to France in September 2014. This visit comprised direct exchanges with professionals involved in organising water management in France, with a particular accent on the Loire-Bretagne basin. In addition, with a view to regional exchanges, a delegation from TSA went to Laos in October 2014 to participate in a seminar on IWRM in Southeast Asia. This seminar, which was organised by OiEau, gathered competent authorities from the six countries in the Mekong River basin (Cambodia, Laos, Thailand, Vietnam, China and Myanmar) to share their experiences on the legal and institutional framework required for implementing IWRM in each country.

These technical training courses and institutional exchanges helped build the knowledge and capacities of Cambodian actors in IWRM in the Stung Sen pilot basin. They also encouraged sharing of experiences between the different regional and international actors involved in managing water resources.

The first phase of this project laid the foundations of an IWRM process in the Stung Sen pilot basin, with the participative preparation of a basin inventory and the identification of priority issues in the basin.

2nd phase: January 2015 - January 2017

The second phase of the project ran from January 2015 to January 2017 and involved continued support for the TSA team in elaborating a plan of action for the Stung Sen river basin. The main activities in this phase comprised:

• Technical training in Cambodia

Three training sessions were organised in Cambodia by experts from the Loire-Bretagne water agency and OiEau. These sessions focused on putting together a programme of measures and the related budget estimation in collaboration with members of the Stung Sen Executive Committee. The objective was to develop a document describing the actions to be taken in the Stung Sen basin including figures. In addition, OiEau ran three courses on managing data and water information systems, which enabled the TSA to build internal capacities to manage and exploit available data in order to produce concise information to make decisions and disseminate information to the public.

• Institutional exchanges with French partners

A delegation comprising members of the Loire-Bretagne and Rhin-Meuse Basin Committees, accompanied by representatives from the respective water agencies, travelled to Cambodia in March 2016. The objective of this visit was to foster exchanges between homologues on the Stung Sen River Basin Committee and the TSA. These exchanges were an occasion to share experiences and best practices related to water management, with an accent on French river basins and the specific context of the Stung Sen basin.

Transfer of assets to the Stung Sen basin at of the Basin Executive Commitee by TSA trainers in 2014. © TSA

These technical training courses and institutional exchanges contributed to building the capacities of the TSA team and the members of the Executive Committee of the Stung Sen basin to establish an action plan for the basin.

3rd phase: February 2017 - June 2019

The third phase of the project concentrated on building the capacities of the TSA team to monitor and implement the action plan. The main activities in this phase comprised:

• Training in France

Two training courses were organised in France for the TSA team:

– In June 2017, two team members took a personalised course organised by OiEau at the French National Training Centre for Water Professionals (CNFME) in Limoges. This course centred on meteorology and water management in river basins.

– In November 2018, four TSA team members took at course at the CNFME on best laboratory practices, sampling, water quality parameters and using measuring kits. The course included a technical field trip, featuring discussions with territorial actors in the Loire-Bretagne river basin (in this case the Marais Poitevin public basin body), in wetlands of interest to the Cambodian partners.

Water sample collection as part of a training on the quality analysis of water in Cambodia (February 2018). © TSA

In March 2016, a delegation composed of members of the commitees of basin and water agencies Loire-Bretagne and Rhin-Meuse, visited in Cambodia to exchange with their counterparts of the Stung Sen Basin Commitee, TSA and MOWRAM.
© OIEAU

• Training in Cambodia
In between the two courses in France, a training course took place in Cambodia in February 2018 run by a trainer from the CNFME. This course aimed to establish an inventory of the analysis material available at the MOWRAM laboratory and train TSA staff on how to use it to analyse the quality of water withdrawn on the field. In addition, during two missions involving experts from the Loire-Bretagne Water Agency and OiEau, training was delivered on communication tools and information campaigns. Joint work on mapping tools involving the OiEau representative in Cambodia and the TSA team also reinforced the team's aptitude to produce maps of river basin networks.

• Institutional exchanges with French and regional partners
In June 2017, as a follow-up to the training in Limoges, the Director General of TSA and the secretary of the Stung Sen Bureau joined the two TSA team members present in France for a study trip to the Rhin-Meuse river basin. This visit included two basin infrastructures and participation at the General Assembly of the Rhin-Meuse River Basin Committee. In January 2019, a delegation composed of basin committee members from the Loire-Bretagne and Rhin-Meuse agencies went to Cambodia to exchange with their homologues from the Stung Sen River Basin Committee and the TSA.

4th phase : July 2019 - May 2022

The fourth phase of the project focused on building the capacities of the TSA team for monitoring and implementing the action plan. The main activities in this phase comprised :

• Training in Cambodia
In December 2019, experts from the Loire-Bretagne agency and OiEau attended a meeting of the basin's Executive Committee. The aim of this meeting was to exchange on a strategy to monitor the implementation of the action plan and its future updating. In addition, in 2020, work commenced between OiEau and the TSA team on collecting and organising data into a dedicated Stung Sen basin database.

• Certifying training in France
During this phase, Chanvoitna PRAK, a member of the TSA team, obtained a specialised master's degree in water catchment area management at ENGEES (national school for water and environmental engineering, Strasbourg) during the 2020-2021 academic year. In her thesis, which she produced in Cambodia, she suggested a list of measures for managing the six water treatment station abstraction points in the Stung Sen basin.

These training courses and capacity-building activities succeeded in developing the skills of the TSA team to monitor and implement the action plan for the Stung Sen river basin. They also fostered the exchange of knowledge and experiences between the French and Cambodian partners, thus contributing to more effective, sustainable management of water resources on this pilot basin.

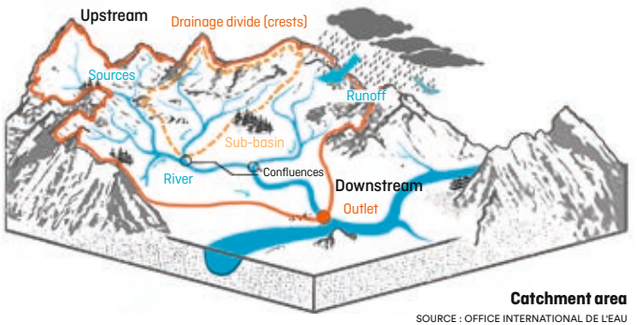
Issues and measures 2016 – 2021

IWRM (Integrated Water Resources Management) is an approach to water management that promotes sustainable, fair use of water resources in river basins. It is a solution to anticipate and resolve environmental problems that impact water management and aquatic ecosystems in river basins. Acting collectively rather than waiting often proves more profitable since it avoids the costs of not acting. Global climate change makes the approach all the more relevant.

Implementing IWRM requires clearly identifying the issues related to water management in the river basin. This involves analysing the pressures on water, user needs and requirements, and environmental targets. By identifying these issues, it is possible to define a suitable programme of measures that takes into account the concerns and interests of the different basin stakeholders.

An IWRM programme of measures comprises a set of concrete actions designed to improve water management in the river basin. These measures can include actions to preserve and restore aquatic ecosystems, actions to regulate water usage, actions to raise awareness and educate, and actions to plan and coordinate between the actors involved.

IWRM promotes a participative approach involving the different stakeholders (whatever the nature of their water



Catchment area

SOURCE : OFFICE INTERNATIONAL DE L'EAU

Training laboratory practices at Cambodia (February 2018).

© OIEAU

usage or their position on the river basin, upstream or downstream) in decision-making and the implementation of measures. This improves the understanding of the issues and promotes acceptance of the decisions made, which contribute to more effective, sustainable management of water resources in the river basin.

By adopting an integrated management approach, IWRM means that water-related environmental problems can be anticipated and resolved more effectively. It promotes coordination and collaboration between the actors concerned, which can lead to considerable economic, social and environmental benefits. By working together and proactively, it is possible to maximise the benefits and minimise the negative impacts on aquatic ecosystems and the communities that rely on them.

To achieve this, it is indispensable to identify the issues and define a suitable programme of measures that responds to the concerns of basin stakeholders.

Defining the issues

The issues facing the Stung Sen river basin were identified in a participative, inclusive way involving all stakeholders. Different consultation methods were applied, like public relations, field surveys and participative workshops.

In 2014, two participative workshops were organised in Kampong Thom and Preah Vihea provinces. These workshops gathered actors from the field, like municipal representatives, farmers, civil society organisations, water users, provincial authorities and the members of the Stung Sen River Basin Committee. The objective of these workshops was to jointly identify the problems and challenges encountered in the river basin.

Once the issues had been identified, they were ranked and split into three themes defined at the 6th World Water Forum: “Ensure everyone’s well-being”, “Contribute to economic development” and “Keep the planet blue”. This classification involved grouping the issues according to their nature and impact, which made it easier to understand the actions to carry out and put them in order of priority.

The participative approach employed to identify the issues took into account the perspectives and needs of all stakeholders, thus involving a more integrated, balanced approach to water management in the Stung Sen river basin. This participative approach contributed to reinforcing the acceptation and ownership of decisions taken, by allowing local actors to play an active role in the water management process.

Ensuring everyone’s well-being involves guaranteeing access to drinking water and sanitation, and reducing health and environmental risks.

Given the worryingly low levels of access to drinking water in rural areas in the Stung Sen basin, it seemed essential to ensure a sustainable, reliable clean water supply that can be efficiently managed to provide sufficient, affordable, safe water at a reasonable distance from people’s homes. Access to sanitation and sustainable services also appears to be crucial to improve public health for inhabitants.

The impacts of water disasters and crises, which cause significant economic damage and impact the daily lives of numerous people, were also a major issue for stakeholders. Consequently, reducing the risks of natural catastrophes

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Ratha Prim

VICE-GOVERNOR OF KAMPONG THOM AND CHAIRMAN OF THE EXECUTIVE COMMITTEE OF THE STUNG SEN IWRM PROJECT

Can you tell us about your role as chairman of the Stung Sen executive committee for the 2022-2027 term?

– As chairman of the Stung Sen executive committee running from 2022-2027, my role is to supervise actions and their planning to ensure that the project runs smoothly. Our executive committee meets twice a year and is in relation with the working groups to discuss subjects like access to drinking water, irrigation, crisis management (like floods and droughts) and communication. We also organise field trips to meet local inhabitants and private water actors.

Can you explain to us the objectives and needs of the project for the future?

– Our priority is to guarantee water usage for domestic purposes during the dry season and better anticipate the management of flash floods downstream in the basin. We also want to guarantee low-water replenishment downstream from the recently built Reaksa Reservoir Dam. To do this, we continue to work closely with all actors to respond to their individual needs fairly.

© TSA

Lay Sim Kim

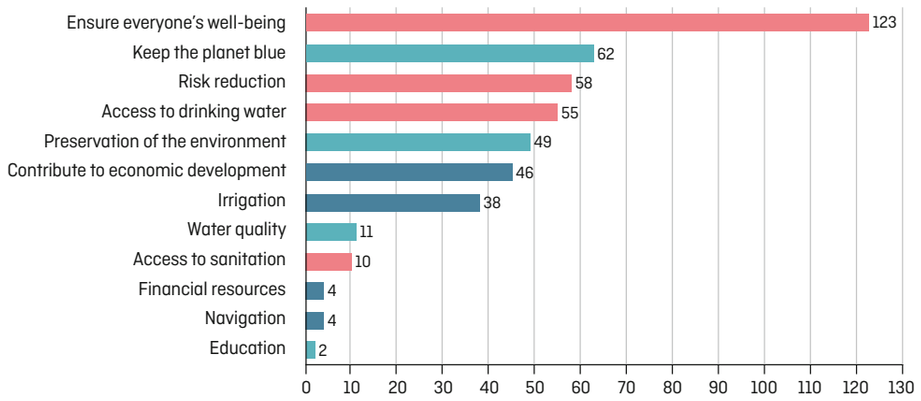
MANAGER OF THE O'KAMBO AGRICULTURAL COMMUNITY, PREAH VIHEA PROVINCE, MEMBER OF THE EXECUTIVE COMMITTEE

Can you tell us about the O'Kambor Agricultural Community that you manage?

– Our community gathers 700 families that work farmland ranging from 0.5 to 5 hectares, over half of it organic. Unfortunately, the current irrigation system is not efficient enough to irrigate all of the parcels, which limits our agricultural production. We would like to benefit from training on farming techniques to improve our practices. We are also looking for markets for all of our agricultural produce, like rice and vegetables. Put simply, our community is determined to improve its living conditions thanks to more profitable agricultural production that respects the environment.

What can you tell us about the Stung Sen project and the partnership with AFD (WAT4CAM project) ?

– In collaboration with MOWRAM, AFD chose our sector to rehabilitate the irrigation system and seek new markets for organic rice. We are delighted with this partnership and convinced that it will help boost our agricultural production. However, we are coming up against problems related to water shortages at the end of the rice-growing season, in other words, the start of the dry season. We hope to find solutions to this problem in order to guarantee quality agricultural production, once the irrigation network has been rehabilitated."



Number of votes by participants at workshops in the two provinces concerning the issues identified. SOURCE : OIEAU

was identified as a strategic priority and an economic necessity. It was therefore deemed indispensable to include prevention, mitigation and disaster responses in the programme of measures for integrated water resources management in the Stung Sen river basin.

According to the actors in the river basin, **contributing to the economic development** of the Stung Sen basin involved in particular developing irrigated agriculture, improving the navigability of the Stung Sen River, and raising sufficient financial resources to improve the living conditions of local inhabitants while preserving ecosystems.

Irrigated agriculture was the solution identified to improve yields by increasing the number of harvests, but this required setting up sustainable management and fair sharing of water resources, along with support measures for farmers, such as through organising farming communities and reinforcing collaboration with the authorities.

River navigation, another important aspect of the region's economic development, should meet inhabitants' needs in terms of exchanges of goods and agricultural produce. However, navigation can be difficult and sometimes impossible in the dry season, and it was therefore crucial to improve the navigability of the Stung Sen and access in order to facilitate commercial exchanges.

More generally, the availability of financial resources was a key issue for the region's economic development, since water supply, sanitation and irrigation facilities required considerable investments. To ensure the financial viability of the water sector, it was important to strike a balance between the different financing sources, and to think of new financial sources relating to pricing, taxes and state aid. It was also essential to draw up a financial plan to support the economic development of this territory while preserving ecosystems.

The theme of **keeping the planet blue** aimed to establish policies and an action strategy to protect water resources and aquatic ecosystem while finding a balance between the impacts, pressures and environmental objectives. Integrated water resources management and the preservation of natural resources were therefore necessary to attain this global objective.

Ensuring the good quality of water from the Stung Sen, which is a key parameter that impacts human health, ecosystems and biodiversity, was crucial for stakeholders. It was therefore important to mobilise sufficient means

to monitor and improve water quality by limiting physical, chemical, organic and microbiological pollution.

Lastly, educating about the environment and sustainable development appeared indispensable to disseminate knowledge and values that promote responsible behaviour in order to maintain or restore the quality of water and the environment.

The four issues identified as a priority for the stakeholders consulted were therefore: to reduce and control the risk of flooding and drought, facilitate access to clean water, preserve the environment, and develop irrigation.

Preparing the programme of measures

Following the identification and prioritising of the issues related to water in the Stung Sen river basin, the members of the basin committee worked closely with experts from the water agencies and OiEau to determine which measures to put in place in response.

The work was carried out in a participative, iterative process that involved the consultation and contribution of basin stakeholders. The basin committee members played a key role in identifying the measures, and applying their specific knowledge and expertise to the Stung Sun's local context.

The experts from the water agencies and OiEau provided technical and methodological support throughout the process. Their experience of managing water and their knowledge of good practices guided discussions and the choice of measures to be implemented.

The measures identified aimed to respond to the specific issues facing the Stung Sen basin, such as managing water quality, preserving aquatic ecosystems, improving access to drinking water, managing water resources for agriculture and other uses, and educating stakeholders and raising their awareness.

It is important to underline that this process of determining measures can evolve over time. The measures identified can be adjusted to take account of the changing context and new scientific and technical knowledge. In addition, the implementation of these measures requires continuous coordination and collaboration between stakeholders in order to ensure their effectiveness and sustainability. To support this, methodological support and a dashboard were put in place. The aim was to record and monitor the progress of the listed measures during the implementation period of the programme of measures.

Mangroves on the shore of the lake Tonle Sap, near the village floating from Kampong Phluk.
© TSA

In total, 54 actions were identified and split between the four issues defined:

1. Ensure everyone's well-being

2. Contribute to sustainable economic development

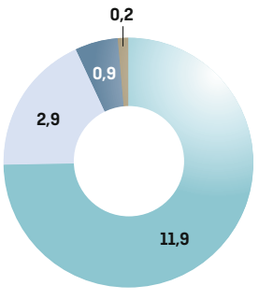
3. Preserve the environment and aquatic ecosystems

4. Ensure good IWRM governance

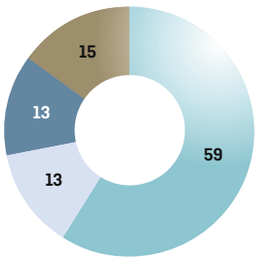
For each of these actions, and in order to facilitate implementation, the team members worked together to identify one or more contracting authorities, the priority, a monitoring indicator, and an estimation of the cost. In total, the cost of the measures was estimated at USD 16 million, split between the different issues.

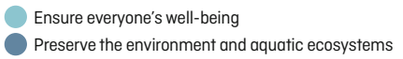
Programme of measures

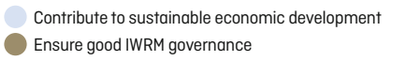
Breakdown of estimated costs by theme *(millions of US$)*



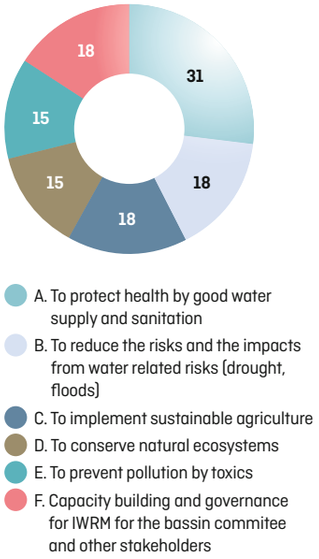
Breakdown of actions by theme *(in %)*







Measures' implementation
2016-2021 *(in %)*



Contents of the programme of measures

The final document listing the 54 actions takes the form of a dashboard organised into four main parts divided into six key types of measure to be implemented during the period 2016 - 2021 and detailed below.

Issue 1. Ensure everyone's well-being

→ **Measure A – Protect health through easy access to clean water and sanitation**

Measure A to protect health through easy access to clean water and sanitation services comprises seven sub-measures broken down into 24 actions.

They concern improved access to clean water, water supply systems, and the conservation and quality of rainwater and groundwater for consumption. They also aim to reinforce sanitation and develop an approach to solid waste management.

→ **Measure B - Reduce risks related to water and their impacts (droughts, floods)**

Measure B to reduce risks and impacts resulting from flooding and droughts comprises two sub-measures broken down into seven actions. They concern managing floods and droughts and defining priority water uses in the case of drought.

Issue 2. Contribute to sustainable economic development by sharing resources (uses and ecosystems)

→ **Measure C – Establish sustainable farming**

Measure C for sustainable farming comprises three sub-measures broken down into seven actions. These measures concern in particular: establishing good farming practices, limiting the use of pesticides, and drawing up a master plan for irrigation.

Issue 3. Preserve the environment and freshwater ecosystems, wetlands, forests and flooded forests

→ **Measure D – Preserve natural ecosystems**

Measure D to protect the environment comprises three sub-measures broken down into seven actions. The main aim is to reinforce protected aquatic natural areas (freshwater, wetlands, floodedforests), ensure sustainable management of forest ecosystems, and develop and promote ecotourism and ecolabels.

→ **Measure E – Prevent pollution from toxic substances**

Measure E only comprises one sub-measure/action aimed at developing an institutional framework to manage industrial wastewater.

Issue 4. Ensure consistent governance of Stung Sen water

→ **Measure F – Reinforce IWRM governance capacities for the basin committee and other stakeholders**

Measure F to reinforce the governance capacities of the basin committee and other stakeholders to implement IWRM in the Stung Sen basin comprises three sub-measures broken down into the following eight actions: clearly define the tasks and objectives of the river basin Executive Committee; develop a communication and awareness-raising strategy with the stakeholders concerned; and ensure sustainable financing for IWRM.

During the preparation of the programme, the following measures were identified as priorities and ranked by order of importance by the members of the Stung Sen River Basin Committee:

- Reduce risks related to water and their impacts (droughts, floods) (measure B).
- Protect health through easy access to water and sanitation (measure A).
- Preserve natural ecosystems (measure D).

Establish sustainable farming (measure C).

Evaluating the implementation of the programme of measures

In 2021, after five years of implementation, an evaluation of the programme was carried out. For each of the 54 actions identified in 2015, its achievement was evaluated using the indicator identified when the plan was drawn up.

The main contracting authorities and French partners of the programme of measures were:

- The ministries concerned: MOWRAM, Ministry of Agriculture, Ministry of Rural Development, Ministry of the Environment, etc.
- Bilateral projects: water agencies, AFD, JICA, KOICA, ADB, WB, etc.
- Associations and NGOs.

The domains of intervention mainly concerned modernising the irrigation systems, promoting good agricultural practices, establishing flood forecasting, and providing support following natural disasters like floods and droughts. Other types of action included preserving natural areas and building drinking water stations.

The results vary from one category of measures to another, but around 70% of all of the measures in the programme running from 2016-2021 were undertaken.

Perspectives

The evaluation of the implementation of the plan and the evaluation of the situation after a first IWRM cycle in the Stung Sen pilot basin highlighted persistent challenges and new issues related to the territory's development. Perspectives were identified for implementing a second IWRM cycle in the basin.

Issue 1. Ensure everyone's well-being

→ **Measure A – Protect health through easy access to clean water and sanitation**

In this area, essential action needs to be carried out to guarantee safe water supply and adequate sanitation. A quality standard for drinking water should be established, accompanied by rigorous, enforced control of raw water quality (rainwater and groundwater). In addition, it is indispensable to prepare a master plan on uses of clean water in the Stung Sen basin to ensure the availability of this vital resource for human health.

→ **Measure B – Reduce risks related to water and their impacts (droughts, floods)**

Management of water-related risks is crucial to preserve inhabitants' well-being. It requires establishing the most comprehensive database possible on the Stung Sen basin's hydrology and climatology, using automatic and manual monitoring stations. These data will make it easier to understand phenomena like drought and flooding and to take the appropriate measures to minimise their impacts.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Issue 2. Contribute to sustainable economic development by sharing resources (uses and ecosystems)

→ **Measure C – Establish sustainable farming**

To achieve this measure, it is essential to establish a list of the pesticides and fertilizers used in the Stung Sen basin, taking into account their diversity and quantity based on specific farming practices like rice-growing, orchards and industrial crops.

Particular attention should be paid to the reasonable use of these inputs, considering the soil quality, type of irrigation, yield, and market requirements.

A list should also be made of the pumping points along the Stung Sen River during the dry season, in particular for irrigating different cultures, in order to ensure balanced management of water resources.

Issue 3. Preserve the environment and freshwater ecosystems, wetlands, forests and flooded forests

→ **Measure D - Preserve natural ecosystems**


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The preservation of ecosystems is key to maintaining the region's ecological balance. To this end, it is important to attentively follow the development and promotion of eco-tourism and ecolabels in order to encourage practices that respect the environment and increase the status of aquatic ecosystems in the Stung Sen river basin.

In addition, it is essential to attentively monitor the impact of the Reaksa Dam, which has been in operation since December 2022, to assess its impact on ecosystems and take necessary measures to preserve them. Note that this project was not known when the programme of measures was drawn up. This example illustrates the need for regular updating of planning tools in order to take into account the evolving, particularly dynamic situation in Cambodia.

→ Measure E - **Prevent pollution from toxic substances**

Preventing pollution from toxic substances to ensure the preservation of water quality in the Stung Sen river basin is a new cause for concern. Tackling this issue requires drawing up an exhaustive inventory of the industrial sites employing 30 employees or more, including identification of their precise location, characteristics and discharges.

This inventory will be used to list the industrial activities that constitute potential sources of pollution and better understand the toxic substances discharged into the environment. This detailed information on the industries present can be used to evaluate their impact on water quality and set up suitable prevention measures.

The inventory of sites also provides a solid basis for developing specific environmental regulations and targeted surveillance programmes. It can be used to identify factories that require particular attention because of their potentially harmful discharges. Working with the companies concerned, actions can be undertaken to reduce the emissions of toxic substances and improve the environmental management of industries.

Thanks to preventing pollution from toxic substances, the Stung Sen river basin will guarantee the preservation of its aquatic ecosystems, the protection of public health, and the sustainability of economic activities that rely on its water resources.

Issue 4. Ensure consistent governance of Stung Sen water

→ Measure F - **Reinforce IWRM governance capacities for the basin committee and other stakeholders**

Consistent water governance in the Stung Sen basin is essential to ensure effective, sustainable management of water resources. To reinforce IWRM capacities and governance, several actions are anticipated.

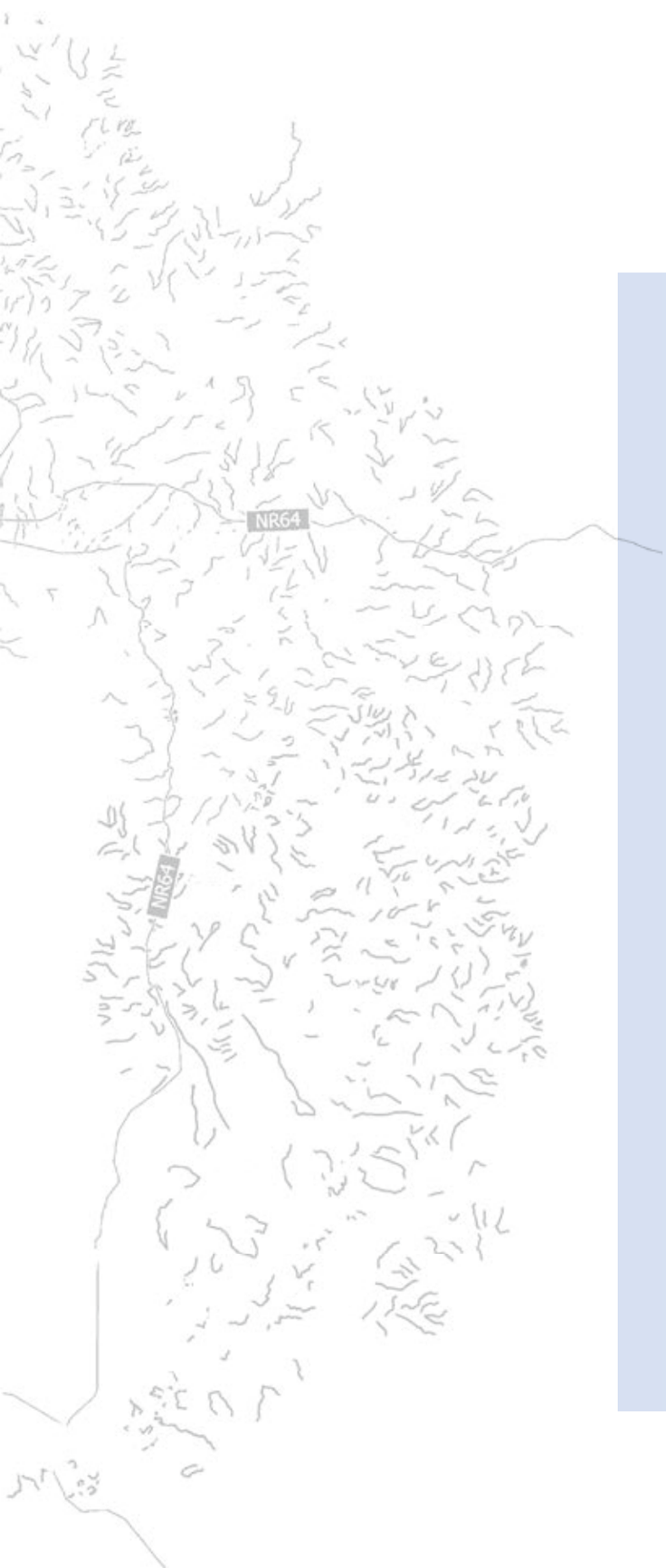
Firstly, the tasks and objectives of the Basin Executive Committee (BEC) shall be set out. This body plays a key role in coordinating and implementing the measures of the action plan. This detailing of the BEC's responsibilities will ensure that its operation is optimised and reinforce its contribution to integrated water management.

Next, it is crucial to develop a communication and awareness-raising strategy to inform and involve all actors concerned. Increasing the awareness of the public, decision-makers and stakeholders is essential to promote sustainable water management and encourage the active participation of all parties.

Lastly, to ensure the future of IWRM in the Stung Sen basin, it is indispensable to secure sustainable financing solutions. This involves exploring different funding sources, establishing partnerships with local and international actors, and guaranteeing the mobilisation of resources required to implement the actions of the programme of measures.

To achieve these perspectives, the Basin Executive Committee was renewed in late December 2022. At the general assembly, its mandate and the creation of technical commissions were approved.

These perspectives constitute an essential road map for the coming years in the Stung Sen river basin. Their aim is to guarantee sustainable development, preserve public health, and protect aquatic and natural ecosystems. The implementation of these actions will contribute to ensuring integrated, participative management of water resources complying with IWRM principles.



SUMMARY / CHAPTER 3

→ Evolving governance and the development of skills are central to optimising water management.

It is essential to interconnect the different scales of governance and to possess a trained, efficient technical team to respond effectively to issues related to preserving water resources and using them sustainably.

At national level, the plan is to set up a management committee for the river basins in Cambodia to ensure the effective management of the seven hydrographic areas in the country. However, this committee has not met to date.

At basin level, the Stung Sen River Basin Committee was created in 2013 with an evolving composition comprising state representatives, elected representatives and users. It role is to coordinate the management of the basin, acquire knowledge on water resources, arbitrate on conflicts of use, showcase the work carried out, and ensure coordination with decentralised cooperation operations. The committee currently has 83 members, split into three sections: state (36%), elected representatives (52%), and users (12%).

To reinforce the activities of the basin committee, an executive committee and a bureau were created, along with specific commissions to deal with priorities for the basin, such as farming, drinking water, and the environment. The Tonle Sap Authority brings its expertise and advises the bodies.

Training sessions coordinated by OiEau and carried out by French experts from the water agencies and OiEau have helped build the knowledge and skills of the Tonle Sap Authority team, and those of some key actors at the Ministry of Water Resources and Meteorology (MOWRAM), and the Stung Sen basin. These training courses established a solid foundation for implementing a policy on integrated management of water resources in Cambodia.

→ Identification of issues and planning of action for optimum water management in the Stung Sen water basin in the medium term

Identifying the issues and planning action are key stages to ensure optimum water management in the Stung Sen river basin in the medium term. Taking an Integrated Water Resources Management (IWRM) approach to defining the issues involves identifying which problems to tackle and which targets to reach. It requires extensive consultation of all basin stakeholders, including public meetings, field surveys and participative workshops.

In the case of the Stung Sen river basin, this participative analysis led to identifying the priority issues, which were grouped into three main themes: ensure everyone's well-being, contribute to economic development, and keep the planet blue. The priority issues comprise reducing and controlling flood and drought risks, access to water, preservation of the environment, and development of irrigation.

Based on these issues identified, a management plan featuring 54 actions was produced and validated by the Stung Sen Basin Committee.

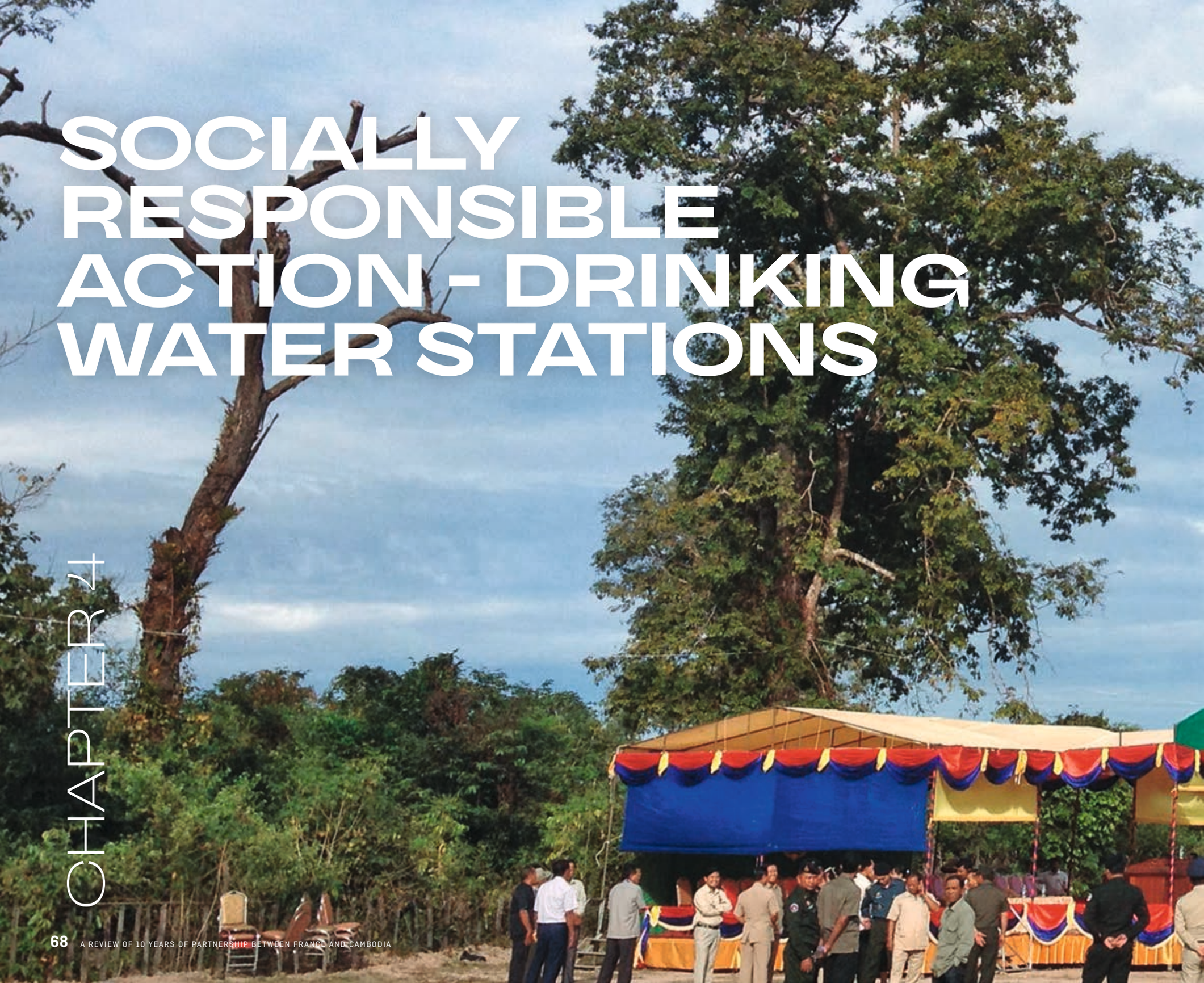
Each action was attributed to one or more contracting authorities, and the priorities, monitoring indicators, and estimated costs were defined to facilitate implementation.

The total estimated cost of all of the measures amounted to 16 million US dollars over a five-year period from 2016 to 2021. The management plan constituted a strategic framework to guide actions aiming to respond to the issues identified and ensure optimum management of water on the Stung Sen river basin.

After a first planning phase, in a context of rapid economic and demographic development in the country, the partners observed a significant shift in the situation. IWRM was not only necessary to initiate dialogue on needs, but it had become indispensable to manage the momentum, with numerous opportunities for cooperation and investment that require guidelines and shared targets. This underlines the relevance of dialogue and planning to establish clear priorities of expectations at river basin scale. Perspectives for implementing a second IWRM cycle in the basin were identified. They will guide the follow-up of IWRM in the basin, establishing a clear connection between the governing body (basin committee) and the planning instruments (programme of measures).

SOCIALLY RESPONSIBLE ACTION - DRINKING WATER STATIONS

CHAPTER 4



Solidarity actions for access to drinking water in the Stung Sen basin: a crucial step towards the health and well-being of communities. Solidarity initiatives are emerging to guarantee access to water for all. These collective efforts aim to improve the quality of life, strengthen public health and promote sustainable development in the Stung Sen river basin. ●

Inauguration of the drinking water station - Association AREED - Municipality of Ngorn - Stung Sen Basin in Cambodia.
© OIEAU

Support, actors, achievements

Socially responsible, decentralised collaborations

Socially responsible collaboration is a great human adventure. The Stung Sen river basin provided a perfect opportunity for the Loire-Bretagne and Rhin-Meuse water agencies to develop ambitious partnership projects with French NGOs, SDEA, MOWRAM and the TSA, to make it easier for rural inhabitants to access drinking water.

This fruitful collaboration involved building the capacities of local communities, encouraging the participation of citizens, and contributing to more sustainable local development.

These projects are part of an overall approach to sustainable development linked to the Sustainable Development Goals (SDGs) in the United Nations 2030 Agenda.

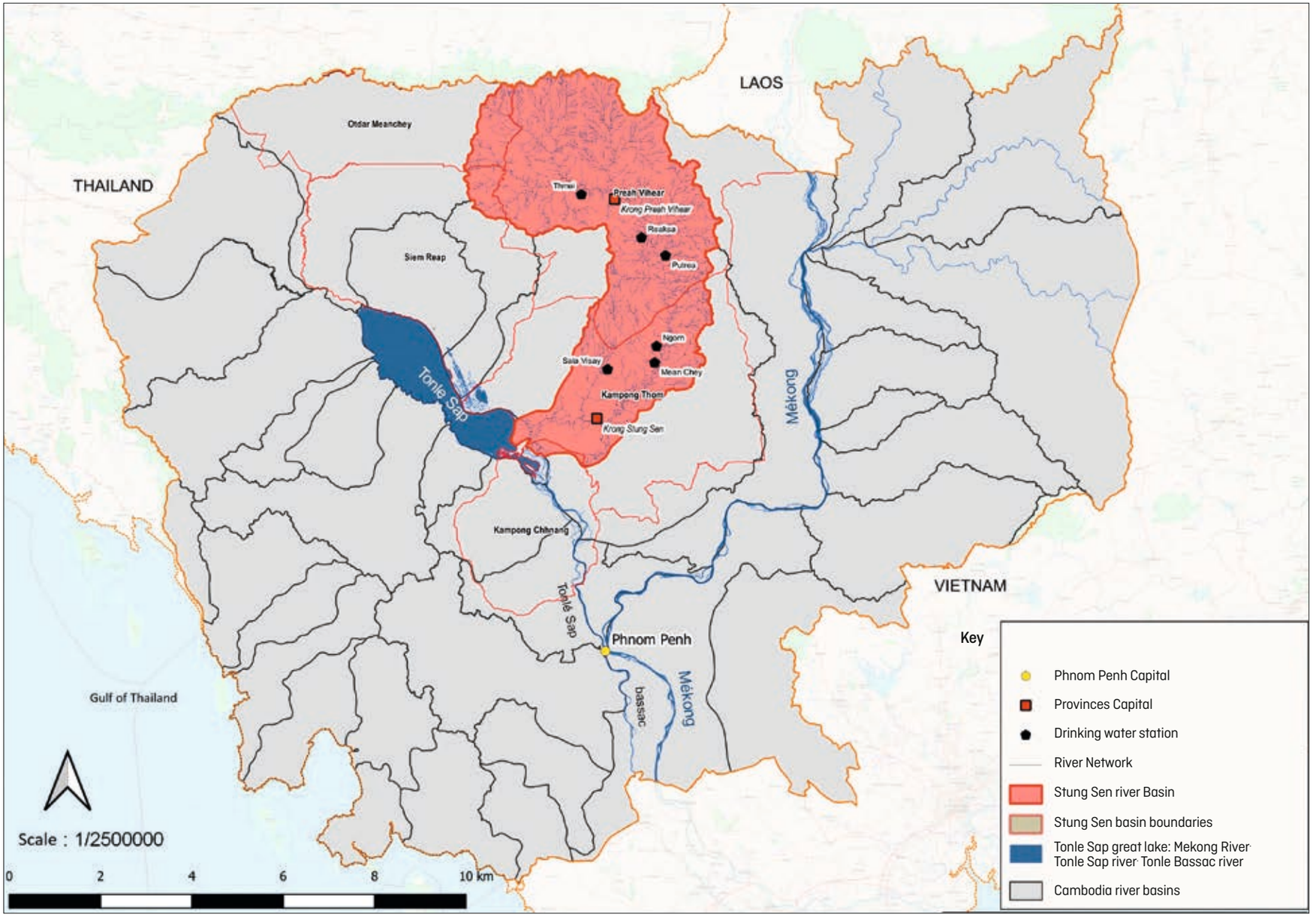
In 2016, the Rhin-Meuse Water Agency established a policy to support the development of socially responsible projects in the Stung Sen river basin. This intervention policy has supported nine local projects aimed at improving access to drinking water and the health and well-being of inhabitants. With a budget of 2.05 million euros for the works, and almost 1.6 million euros of aid from the Rhin-Meuse Water Agency, local actors benefited from considerable financial support to establish concrete, useful projects.

To successfully implement all of these works, teams from the TSA, MOWRAM and OIEau worked in collaboration with representatives from NGOs, based in the MOWRAM offices at Phnom Pehn, to jointly come up with concrete solutions adapted to local needs.

In 2018, the Loire-Bretagne Water Agency supported the installation of 25 Safe Water Cube fountains in the floating villages on Tonle Sap Lake. This initiative aimed to supply drinking water to 25,000 people facing difficulties in accessing quality water. The budget allocated to this operation amounted to € 180,000, of which € 108,000 are financed by the Loire-Bretagne Water Agency.

Safe Water Cubes are innovative measures that purify water thanks to an efficient filtration system that does not require electricity. This action by the Loire-Bretagne Water

Domestic water collection at Preah Vihea.
© OIEAU



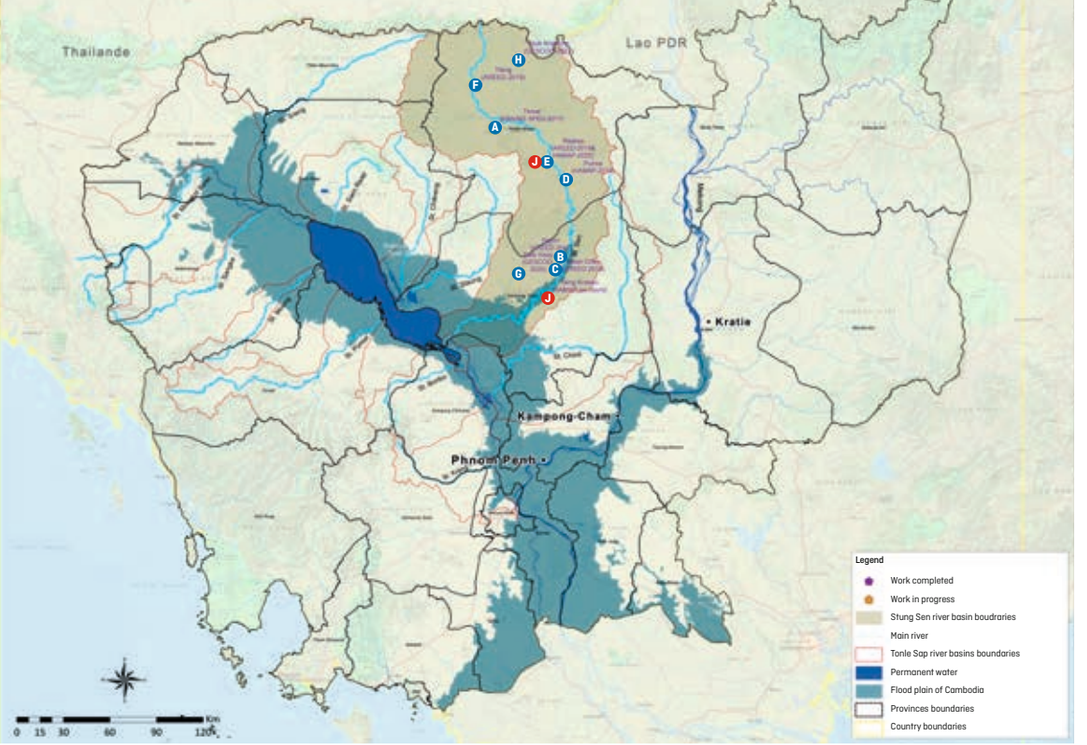
Map of Cambodia and the Sen river basin

The 6 drinking water treatment plants financed by the cooperation French in the Stung Sen watershed, 2021. SOURCE TSA

Basin of the Stung Sen

Situation at 30/06/2023

SOURCE TSA



Agency contributes to improving the health and well-being of local inhabitants.

Lastly, a project driven by GRET was the 2021 winner of the "Water and International Solidarity" call for projects to improve access to water and sanitation for the municipalities of **Ruos Rean** and **Rieb Rob** (4,875 beneficiary inhabitants - Preah Vihea province). The cost of the works was estimated at €360,746 and included financial aid of €195,198 managed by the Loire-Bretagne Water Agency.

Context and nature of the socially responsible operations financed

Situation and needs

The rural provincial municipalities in the basin have specific needs in terms of drinking water supply. Each municipality comprises from a few to dozens of villages, scattered over the area. These villages house from hundreds to thousands of families, generally with five to six members. The municipalities have primary schools, sometimes a middle school and/or a high school, a pagoda and a health clinic.

Water supply for these sectors comes from a number of sources, including:

- Shallow wells of a few dozen metres, sometimes artesian, connected to the water table or the alluvial aquifer.
- Open-access bore holes financed by international aid and equipped with manual pumps.
- Rainwater collection during the wet season.

However, this situation involves fetching water, which is mostly done by women and children.

The quality of drinking water along the Stung Sen River is often impacted by the presence of bacteria, iron and arsenic, and its supply can be erratic during the dry season, which creates problems in supplying local inhabitants.

Those inhabitants who can afford it buy drinking water in 20-litre canisters from private retailers for about 2,000 to 3,000 riels a canister, or 0.50 to 0.75 US dollars. Families generally consume one or two canisters a day, although quantities vary considerably from the wet season to the dry season.

	DESCRIPTION	DATE IN OPERATION	OPERATOR	NO. INHAB.	NO. FAMILIES	COST (€)	AID (€)
A	Drinking water supply for **Thmey** municipality (Preah Vihea province)	February 2017	KRAING SPEU	2,000	744	136,000	80,000
B	Drinking water supply for **Ngorn** municipality (Kampong Thom province)	November 2017	AREED	4,000	1,274	180,000	122,000
C	Drinking water supply for **Mean Chey** municipality (Kampong Thom province)	July 2018	AREED	4,000	1,610	131,250	105,000
D	Drinking water supply for **Putrea** municipality (Preah Vihea province)	June 2019	HAMAP	5,000	1,616	209,000	168,000
E	Drinking water supply for **Reaksa** municipality (Preah Vihea province)	June 2019	AREED	3,000	811	150,700	115,700
F	Drinking water supply for **Yieng** municipality (Preah Vihea province) – project interrupted by AREED	2019	AREED	6,000	1,358	160,000	128,000
G	Drinking water supply for **Sala Visai** municipality (Kampong Thom province)	May 2020	GESCOD	10,000	3,011	220,000	176,000
H	Drinking water supply for **Teuk Krahorm** municipality (Preah Vihea province)	December 2022	GESCOD	7,122	1,783	394,800	315,840
I	Training of six water management committees	Underway	HAMAP	-	-	118,485	94,788
J	Improvement of access to water and sanitation in **Reaksa** and **Tang Krasov** municipalities	Underway	HAMAP	4,015	-	353,010	282,408

finished Underway

© TSA

Mono Heng

MAYOR OF PHAT SANDAY MUNICIPALITY

« I am proud to have participated in the Stung Sen IWRM project since the start, which has had an impact on improving access to drinking water for people in rural communities. However, climate change over recent years has affected the quantity and quality of river water, in particular during the dry season from March to May, making water dangerous (eutrophication, presence of parasites and pathogenic bacteria) and often unsafe for inhabitants to bathe in. In my municipality, located on the banks of Tonle Sap great lake, we have restored the water treatment plant and benefited from five Safe Water Cube drinking fountains for schools to meet pupils' daily requirements.
We need additional support to ensure the long-term operation of the water treatment plant. In the future, we also hope to benefit from a treatment plant drawing from the water table. By working together, we can guarantee safe, sustainable access to water for rural communities, and adapt to climate change. »

Fishing on the Tonle Sap.
© OIEAU

Standard content of projects

The socially responsible projects carried out in the Stung Sen river basin aim to improve access to drinking water for local people, and to equip schools and health centres with functional sanitary facilities.

The projects feature numerous, ambitious expected deliverables. Firstly, the intention is to produce adequate infrastructures to make it easy to access drinking water from boreholes equipped with pumps.

Next, a functional drinking water service is set up to guarantee a regular, reliable supply of drinking water. Schools and health centres are also equipped with sanitary facilities to guarantee a healthy, hygienic environment for pupils and patients.

The local social adoption of services related to water is also encouraged through new practices, in order to guarantee the sustainability of these projects over time. Local inhabitants are involved at every stage of the implementation of the projects in order to guarantee their active participation and long-term commitment.

To achieve this, works follow a clearly established overall plan. Firstly, preliminary studies are performed, included analyses of soil and water carried out by the Institut Pasteur in Phnom Pehn, along with pumping tests and network modelling.

The installations are set up on municipal land, with the creation of a borehole about forty metres deep equipped with solar pumping, a water tower made from reinforced concrete including a reservoir, a machine room and chlorination measures, along with a first main gravity-fed network made from HDPE supplying water fountains in the different villages. It is worth noting that the priority is to ensure that the purchases, engineering and entrepreneurship involved in the material and works are provided by local builders. Each project also includes local participation from beneficiaries and is supported by MOWRAM.

The long-term objective is to create a second supply network to bring water to inhabitants' homes through junction boxes and individual meters. The electricity supply for the installations comes from solar panels on top of the reservoir.

Taps and toilets are also installed in schools, with a preference for double-pit latrines.

Awareness-raising sessions are organised for schoolchildren and inhabitants on the theme of hygiene, preferably carried out by a Cambodian humanitarian association.

A management committee is formed along with a technical team to manage and operate the installations, ensure the water supply and long-term awareness in schools and villages. The projects aim at setting up facilities for the long term with an autonomous water supply. This approach includes the sale of water, which brings the committees sufficient revenues to cover operating costs, maintenance, and the salaries of the water carrier responsible for distribution.

Concerning the quality of raw and distributed water, a more extensive analysis of the physicochemical and bacteriological parameters was carried out in July 2021 at the six drinking water withdrawal stations in the basin. The results showed the following:

- For raw water, in other words groundwater supplying drinking water treatment stations, the water is considered to be of very high quality.
- For water distributed after chlorine treatment, the quality complies with drinking water standards. The water supplied by the six stations is regularly sampled (every two months) for analysis by the MOWRAM-approved laboratory.

It is a cause of concern that, after only one year of operation, quality monitoring of the water supplied by the drinking water treatment stations on the Stung Sen basin was often interrupted due to technical and administrative problems in the management committee. This lack of monitoring of water quality creates risks for consumers.

Frequent staff changes or a lack of training and practice for technicians can for example lead to insufficient knowledge about the correct dosage of aluminium sulphate which is used in water treatment. This situation can expose consumers to a risk of excessive amounts of this chemical.

Water can also be contaminated by waste water from surrounding residences when a protection perimeter is not in place.

School bus on the Stung Sen at Phat Sanday.
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Christian Szacowny

FORMER MANAGER OF INTERNATIONAL ACTION AT THE RHIN-MEUSE WATER AGENCY

« Since 2016, support for socially responsible operations on the Stung Sen river basin has delivered access to drinking water for the inhabitants of seven municipalities, with four other municipalities expected to benefit in the next few years. The two types of cooperation involved on the Stung Sen project – socially responsible and institutional – are closely related and mutually beneficial. The information and knowledge gleaned on the field fed into the action plan, which guided decisions to carry out the water projects. This constant collaboration was key to the project's success over a period of more than ten years.
To be successful, a socially responsible project needs to be long term in order to allow the different partners, both Cambodian and French, to work closely and in confidence. The management of drinking water facilities should be monitored carefully so that inhabitants can benefit from a quality drinking water supply, which guarantees continuity. Thus, the GESCOD association and the Alsace Moselle water and sanitation authority, with support from the water agencies, the French Ministry for Foreign Affairs, MOWRAM and the TSA contributed to setting up a drinking water management cooperative gathering the different municipalities in the Stung Sen river basin. The aim is to make the cooperative technically, administratively and financially autonomous in a few years to guarantee long-term access to drinking water for inhabitants. This operation is part of a decentralised cooperation agreed between the SDEA and the TSA in 2021. »

These difficulties in managing drinking water treatment plants in the Stung Sen basin underlined the importance of acting fast. The TSA team proposed concrete solutions to resolve these problems and guarantee the optimal performance of the stations. A comprehensive approach combining training, stronger governance and rigorous monitoring was recommended.

It is thus crucial to improve the technical and administrative management of drinking water treatment stations by building staff skills and setting up rigorous water monitoring procedures. Regular, specialised training sessions should be provided to elected representatives and technicians so that they are fully aware of the technical aspects and dosage of chemicals employed in water treatment.

Structured, effective governance for each station is also essential. This involves close coordination between the management committee and station technicians, involving regular communication, exchanges of information and concerted decision-making. All stations must be rigorously monitored, with water quality control procedures, regular inspections, and continuous evaluation of performances and human and material resources.

To guarantee the sustainability of these improvements, it is indispensable to provide long-term technical assistance. Qualified local experts must be available to provide continuous technical support, including training, regular on-site visits, technical assistance and monitoring of the performance of stations. The objective is to develop the skills of local actors and ensure that they can autonomously manage and maintain drinking water treatment plants.

By implementing these measures, it will be possible to overcome the current difficulties and considerably improve the operation of drinking water treatment stations in the Stung Sen basin. The result is guaranteed access to quality drinking water to preserve the health and well-being of basin inhabitants in the long term.

This ambitious project also aims to transform the existing management committees into a larger, inter-municipal structure responsible for managing and operating the natural "water heritage".

This move towards an association for managing drinking water gathering the municipalities on the Stung Sen basin is the result of a collaboration between the GESCOD association, the Alsace Moselle water and sanitation authority, the water agencies, the French Ministry for Foreign Affairs, MOWRAM and the TSA. This approach is the first decentralised cooperation carried out on the Stung Sen basin with a French authority in charge of managing water. It has the advantage of benefiting from the experience of elected representatives and technical services that deal with operating a public water service on a daily basis.

The ultimate objective of this initiative is to make the association autonomous in the medium term, in order to

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Hin Chen

MAYOR OF SALA VISAI MUNICIPALITY

« Since my election as mayor of Sala Visai in 2017, I have insisted on the importance of clean water for our community. We solicited the Stung Sen IWRM project to obtain a drinking water treatment station, which we were finally granted in 2019, with operation starting in 2020.
The quality of the treated water is excellent and the local population is very appreciative. However, given the high demand, the supply network needs to be extended. We are currently working on this extension with support from our partners.
Since December 2022, I have also had the honour of acting as chairman of the Stung Sen drinking water station association. With help from GESCOD and SDEA, we are working together to ensure the smooth operation and sustainability of the drinking water stations that the Stung Sen project has helped us to obtain. We are determined to provide clean, safe water to our community in an efficient, sustainable manner. »

guarantee sustainable access to quality drinking water for local inhabitants.

This approach of promoting decentralised socially responsible projects in the Stung Sen river basin is a concrete example of a success story that continues to evolve and could inspire other similar initiatives around the world.

The project illustrates the need to maintain a close relation between the notion of territory and the rationale of a river basin, thus reinforcing connections and benefiting both scales. This synergy can be encouraged through concrete spaces for dialogue, such as the "clean water" working group, which can draw from both good practices and the local challenges encountered. The result is an integrated, coordinated approach to managing water resources, while promoting collaboration and exchanges of fruitful experiences.

This experience highlights the importance of international solidarity and the construction of a fairer, more sustainable world, in particular in the crucial area of access to drinking water.

◄ Hand pump in a Preah Vihear's school. © OIEAU

SUMMARY / CHAPTER 4

DECENTRALISED COOPERATION: ACCESS TO DRINKING WATER IN THE STUNG SEN RIVER BASIN THANKS TO FRUITFUL COLLABORATION

Local actors, institutional partners and French NGOs combined forces to improve water management and access to drinking water in the Stung Sen river basin so that local inhabitants can benefit from this vital resource.

The quality of drinking water along the Stung Sen River is often affected by the presence of bacteria, iron and arsenic, and its supply is erratic during the dry season, creating problems supplying local inhabitants.

Nevertheless, thanks to close collaboration, significant progress has been made to improve access to drinking water in seven priority municipalities, and soon four more. The operations were financed by the Rhin-Meuse Water Agency and comprise a borehole, solar pumping, a water tower, a supply system and standpipes. Schools and health centres are also equipped with sanitary facilities to guarantee a healthy, hygienic environment for pupils and patients.

In addition, since 2018, thanks to support from the Loire-Bretagne Water Agency, schools located in villages in the Tonle Sap area have been equipped with 25 Safe Water Cube drinking fountains. This project's main aim is to improve the health of pupils and create conditions more conducive to learning.

To ensure a regular, reliable supply of drinking water, each municipality has established a functional drinking water service involving consumers and defined a water price.

The objective was to help committees move towards an inter-municipal association responsible for managing and operating the natural "water heritage". This association was established in 2022 and draws from the experience of the association GESCOD, the Alsace Moselle water and sanitation authority, with support from the water agencies, the French Ministry for Foreign Affairs, MOWRAM and the TSA.

This experience of socially responsible, decentralised cooperation in the Stung Sen river basin is a concrete example of a success story that, while improvable, could inspire other similar initiatives around the world. The project pursues an international solidarity perspective and is fully in line with the UN Sustainable Development Goals.

Collection of data and aerial images in the Stung Sen basin.
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Integrated Water Resources Management on the Stung Sen river basin

10 years of fruitful partnership between France and Cambodia for sustainable water management

The particular interest of this project is its combination of institutional and decentralised cooperation, with the support of two French water agencies. This project led to the establishment of concerted measures for sustainable water management, including improved access to drinking water in the municipalities identified as priorities in the basin. Over the last ten years, five phases of action have been implemented and led to the detailed elaboration of a sustainable programme for integrated water resources management, adapted to specific local features.

The 520km-long Stung Sen River is the main tributary of Tonle Sap Lake, crossing two provinces, Preah Vihea and Kampong Thom, before flowing into Tonle Sap great lake. A basin characterisation and a cartographic atlas of the basin have been produced. The hydrological regime is characterised by very large variations in flow depending on the season, with a severe risk of low water from March to April that can impact usage. Until 2022, the Stung Sen River was a natural watercourse featuring no hydraulic installations. However, a dam has since started operating in the upstream part of the river. In rural areas, fewer than 20% of inhabitants have access to quality drinking water supplied by a public system. Drinking water comes from numerous different sources in different households and the quality of water for consumption can be problematic.

Climate change coupled with the area's economic development have generated several impacts: a spectacular reduction in forest cover over the last 15 years; an increase in water withdrawals, irrigated surfaces and diffuse pollution from farming; and more frequent, severe and extensive floods and droughts that affect inhabitants and farmers.

For the Stung Sen river basin, considering these issues involved a wide-ranging consultation of all stakeholders through public meetings, field surveys, and participative workshops. This participative analysis led to the identification of the priority issues which were then split into three issues, corresponding to those established at the 6th World Water Forum in 2012: "Ensure Everyone's Well-being", "Contribute to Economic Development" and "Keep the Planet Blue". The four priorities identified were to reduce and control the risk of flooding and drought, to ensure access to water, to preserve the environment, and to develop irrigation.

A management plan featuring 54 actions was produced and validated by the Stung Sen Basin Committee in response to the issues identified. Each of these actions was attributed to one or several contracting authorities, along with a definition of the priority level, a monitoring indicator and the estimated cost to facilitate implementation. In total, the measures were evaluated at a total cost of 16 million US dollars, for five years. To date, 70% of the actions have been undertaken.

Local actors, institutional partners and French NGOs are working together to improve water management and access to drinking water. The French decentralised cooperation has already led to the construction of clean water systems in seven priority municipalities and four others will soon be equipped, so that local inhabitants can benefit from a vital resource. The operations were financed by the Rhin-Meuse Water Agency in cooperation with French authorities and comprise a borehole, solar pumping, a water tower, a supply network, and standpipes. Schools and health centres are also equipped with functional toilets to guarantee a healthy, hygienic environment for pupils and patients.

For each station built, a management committee was set up and trained to ensure sustainable management of clean water provided to inhabitants of the municipality. The aim was to help committees move towards an inter-municipal association responsible for managing and operating the natural "water heritage". This was created in late 2022 drawing on the experience of the GESCOD association and the Alsace Moselle water and sanitation authority, with support from the water agencies, the French Ministry of Foreign Affairs, MOWRAM and the TSA. This decentralised cooperation experience in the Stung Sen basin is a concrete success story that could inspire other similar initiatives around the world. This approach fits into an international solidarity perspective and is fully in line with the UN Sustainable Development Goals.

In addition, in 2018, schools in Tonle Sap villages benefited from 25 Safe Water Cube drinking fountains thanks to support from the Loire-Bretagne Water Agency. This project aims to improve the health of pupils and create conditions conducive to pursuing their schooling.

The success of this pilot integrated water resource management project in the Stung Sen basin is the fruit of a successful partnership between France and Cambodia. Nevertheless, it is important that this collaboration should continue in the future to accompany Cambodia in establishing an integrated water resources management plan at national scale, covering the country's seven main river basins.

One of the keys to the success of this pilot experiment resides in the institutional support provided by decentralised cooperation. Thanks to this support, part of the action plan was implemented and concrete achievements were made. This complementary aid played an essential role in legitimising the planning efforts made and allowing members of the basin committee to adopt the plan and observe its concrete impacts. It is essential that stakeholders and inhabitants can observe the short-term benefits of integrated water resources management in order to guarantee its long-term sustainability.

A relationship with water resources established from an early age in floating villages.
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Local fishermen. © TSA


Reaka restraint on the Stung Sen. © TSA

To ensure the success of integrated water resources management throughout the country, the Cambodian government must reinforce the resources available. This involves allocating sufficient budgets for the establishment and operation of basin committees, and for implementing action scheduled in management plans. It is also necessary to set up inter-ministerial coordination mechanisms and to ensure effective collaboration between the different governmental bodies involved in water management.

Moreover, investments should be made in building the capacities of the actors involved, in particular basin committees, technicians and water managers. This can be done through training and awareness programmes, and through sharing good practices and successful experiences in the domain of integrated water resources management.

Lastly, active stakeholder participation, including local communities and water users, is fundamental for successful integrated water resources management. It is important to promote public action, transparency and inclusion in decision-making processes relating to water management, in order to guarantee that the needs and concerns of all stakeholders are taken into account.

By reinforcing the resources available and encouraging participation and coordination between actors, the Cambodian government can create conditions conducive to the success of integrated water resources management throughout the country, thus ensuring the sustainable and fair management of this vital resource.

This IWRM support project was carried out in an evolving context subject to very rapid economic and social changes. The Cambodia of 2023 is very different from the Cambodia of 2012. The Stung Sen basin, which was at the time subject to a low level of human intervention, is no exception. It has undergone drastic modifications illustrated by several examples (critical reduction of forest cover in a decade and emergence of investments in major infrastructures, like the Reaska Dam, etc.). The IWRM toolbox is built on this reality, but it has the advantage of being flexible and able to adapt to these kinds of change. By strengthening ownership, it must accompany these changes and understand them to better guide the pathway of water resources management to the benefit of inhabitants and according to their expectations.

The decentralised cooperation initiative on the Stung Sen also serves as a learning resource to replicate the experiences acquired. Firstly nationally, with the emergence of IWRM projects around the Tonle Sap, taking into account the Stung Sen experience. For example, the WAT4CAM project and the current pilot project on the Stung Sangker, which is considerably enriched by the case history of the Stung Sen, in a very different context. And then internationally, with the water agencies' launch in 2021 of a call for cooperation projects in the areas of the world where they carry out institutional partnerships, with an ambition to develop this joint approach between basins and territories.

To watch the seeds sown by the Stung Sen experience also flourish elsewhere is a true mark of success.

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Review panel: David BOURMAUD, Hervé GILLIARD, Alain BERNARD, Rémi BOYER.

Acknowledgements:

This work was published thanks to financial and technical support from the Rhin-Meuse and Loire-Bretagne water agencies, Tonle Sap Authority, and the International Office for Water, as part of a project to implement integrated water resources management in the Stung Sen river basin.

We would sincerely like to thank His Excellency LIM Kean Hor, Minister of Water Resources and Meteorology in Cambodia, and President of the Tonle Sap Authority from 2009 to 2013, for his unfailing support throughout this Franco-Cambodian collaboration initiated in 2012 in the Stung Sen river basin.

Our thanks also go to the directors of the Loire-Bretagne and Rhin-Meuse water agencies, which have supported us throughout these ten years.

We gratefully acknowledge Mr Jacques OUDIN, who thanks to the Oudin-Santini Act constitutes the cornerstone of this partnership with Cambodia and the international solidarity action carried out by water agencies.

All of the studies and research required to produce this publication were carried out by the Tonle Sap Authority, in association with the Cambodian Ministry of Water Resources and Meteorology, and by the members of the Stung Sen river basin Committee, with the support of French partners. We thank all of the people in these organisations who participated, closely or remotely, and invested their time and energy to make the project what it is today. Our thanks extend to other organisations, institutions and people present on the field for their valuable assistance to our project.

Lastly, many people contributed more or less directly to producing this publication through their work or specific aid. We thank each and every one of them.

Photo credit on cover : © TSA
Graphic design & layout : Agence Efil - www.efil.fr
Print : ISF Imprimerie - 100 copies
Date : june 2024

This publication resonates like a collective symphony dedicated to the preservation of water resources, composed throughout the years, and to which each individual working for the Stung Sen river basin has added their own melodious note to produce a harmonious score.

TONLE SAP AUTHORITY

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