



Water & Development
Research Group



Tonle Sap now and in the future?

POLICY BRIEF of the 'Exploring Tonle Sap Futures' study



EXPLORING TONLE SAP FUTURES?

This Policy Brief summarises the main findings of the so-called ‘Exploring Tonle Sap Futures’ study that focuses on the Cambodia’s Tonle Sap Lake area. The study is implemented by a consortium consisting of Aalto University, 100Gen Ltd., Hatfield Consultants Partnership and Institute of Technology of Cambodia, complemented with work by EIA Ltd. and VU University Amsterdam. The partners of the Tonle Sap study are the **Tonle Sap Authority (TSA)** and the Supreme National Economic Council (SNEC).

The study represents one of the five local case studies of the ‘Exploring Mekong Region Futures’ project, led by the Commonwealth Scientific and Industrial Research Organisation (CSIRO). For more information on the regional project, see <http://bit.ly/Mc9geV>

For more information on our research and scenario work in the Tonle Sap, please see the Final Report of our study (text box on last page). **We welcome questions and comments on our work:** please email them to Marko Keskinen (@aalto.fi).

TONLE SAP NOW: CURRENT SITUATION

The Tonle Sap Lake is among the modern world’s natural and cultural wonder. Its fish productivity and unique flood pulse system have been the driving forces for the development of the surrounding societies at least since the Angkorian era in 9th Century.

Today, the lake-floodplain system is a biodiversity hotspot that forms the ‘fish

growing factory’ of the Mekong River. The fisheries and rice fields of the Tonle Sap create the basis for the food security and livelihoods of millions of Cambodians. People have adapted to enormous annual variation of the lake’s water level by building their homes on stilts and even by living in the lake on floating houses. The annual rhythm of water defines the rhythm of life.

Hydrology and flood pulse

The foundation for the Tonle Sap lake-floodplain system is flood pulse, caused by the lake’s close connection with the Mekong River. During the southwest monsoon, the Mekong flow causes the entire Tonle Sap River to reverse its flow back towards the Tonle Sap Lake, which is a hydrological phenomenon globally unique for a river of this size and foundation for the Tonle Sap flood pulse. Flood pulse drives the high aquatic productivity of the lake, enabling immense fish production. It also explains to large extent the ecosystem conditions and habitats in the floodplain.

The Tonle Sap flood pulse has two critical dimensions: water flow & nutrients. Water flow determines the key characteristics of the flood pulse, including its timing, amplitude, extent and so forth. Water flow thus defines the water level and extent of flooding in the Tonle Sap.

Nutrients refer to the suspended sediments flowing from the Mekong to the lake, bringing a major nutrient boost that is a key driver for the aquatic production and also helps agriculture in the floodplains.

People and their livelihoods

In 2008, there were some 1'707'000 people living in the Tonle Sap area as defined in this study. There are 1555 villages, with a great majority (1244) being rural.

Demographically remarkable is the dominance of the youth: as of today, the two biggest age groups are between 15-19 years and 20-24 years (Figure on right).

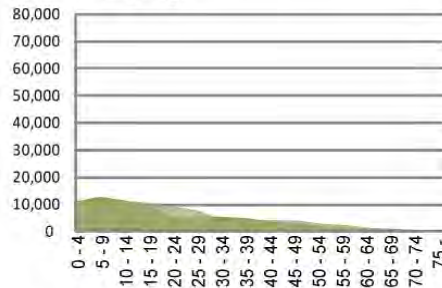
This 'youth surge' is thus just entering the work force, changing dependency ratio and creating enormous challenge –but also possibility– for livelihood structure and labour market.

Agriculture dominates the livelihood activities in the Tonle Sap area: it is together with fishing the basis for national food security. Fishing forms critical livelihood source close to the lake, while in urban areas the livelihood sources are much more mixed.

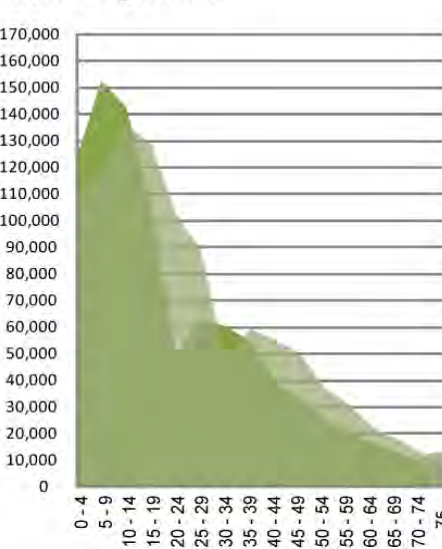
According to the Population Census 2008, 61% of total work force has agriculture as the main livelihood source. Trade comes second (11.5%) and fishing third (4.5%). Yet, the role of fishing is actually much more significant as it provides many with an additional source of livelihood and income. The CSIRO Tonle Sap Household Survey indicates similar figures, although the proportions of trade (around 20%) and fishing (5.8%) are higher than in Census.

Population by five-year age groups

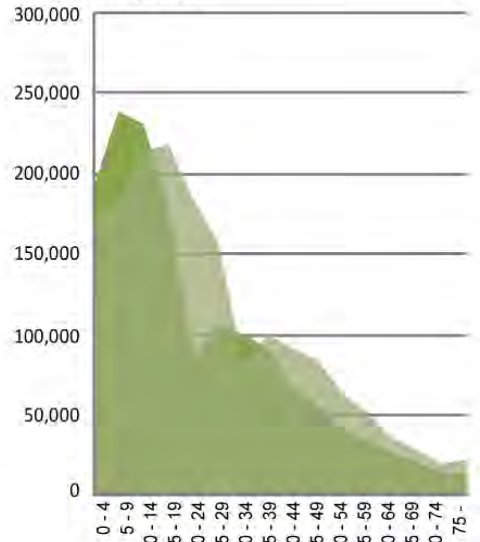
Zone 1 "Fishing"



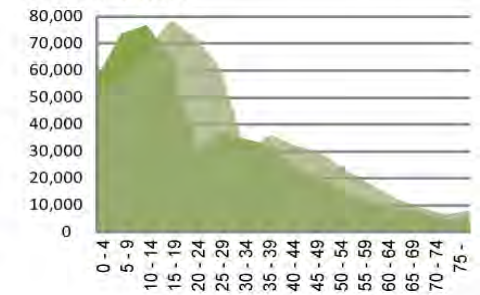
Zone 2 "Agriculture"



Whole study area



Zone 3 "Urban"



In terms of livelihoods, the Tonle Sap area can be divided into three distinct entities: Fishing zone (5% of population), Agricultural zone (60%) and Urban zone (35%). The livelihood profiles of the three zones are very different, although all zones see also interactions, including seasonal and permanent migration. Our analysis indicates that there are also major differences within each zone and even within each of the 18 sub-zones that were formed based on administrative boundaries i.e. the six Tonle Sap provinces. In general, Fishing Zone is in the most disadvantageous situation, while Urban Zone is least dependent on natural resources.

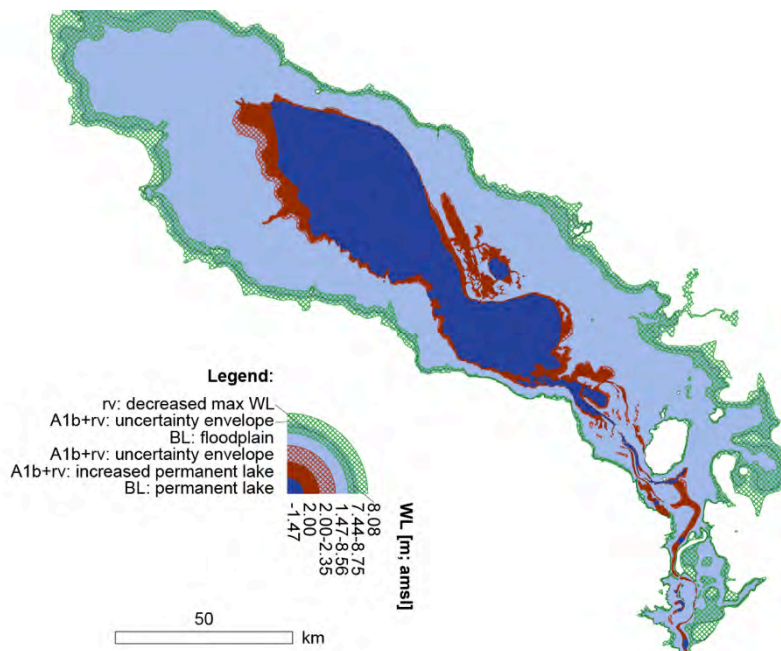
TONLE SAP IN THE FUTURE: CHANGES

The Tonle Sap area is likely to change dramatically within next 30 years. Such changes are driven by both internal and external factors, and range from population growth to urbanization and from livelihood aspects to environmental issues. Our analysis looked at two particularly critical change factors:

- 1) already on-going demographic changes in the Tonle Sap and entire Cambodia, and
- 2) estimated hydrological and environmental impacts in the Tonle Sap flood pulse due to Mekong hydropower development and climate change.

Changes in flood pulse, floodplain area & fisheries

Example from hydrological modelling results: cumulative impacts of hydropower reservoirs and climate change for the Tonle Sap floodplain



The Tonle Sap lake-floodplain system is impacted from changes occurring in both Tonle Sap's own catchment (86'000 km²) as well as those occurring in the entire Mekong River upstream from Phnom Penh (680'000 km²). The connection to the Mekong makes the Tonle Sap particularly vulnerable to hydrological and environmental changes, caused both by water development (e.g. hydropower dams) and climate change.

Within the timeframe of our study (years 2032-2042), the planned Mekong hydropower

development has clearly stronger impact to the Tonle Sap flood pulse than climate change: it is estimated to have a major impact on both nutrient flows and water flows. Climate change brings increasing uncertainty to the estimates: in many cases even the direction of the change caused differs depending on the GCM used, suggesting that the exact long-term impacts of climate change are far from clear.

Cumulative impacts of climate change and hydropower operation will significantly impact the Tonle Sap flood pulse, leading to delayed, shorter, and smaller flood and higher dry season water level. In addition, the hydropower dams are estimated to

significantly reduce the inflow of nutrient-rich sediments to the Tonle Sap system. They will, naturally, also have an impact to the fish migration.

The changes in water flows alter flood pulse dynamics, leading to significant reduction in floodplain area (see figure above). Together with reduction in sediment inflow and negative impacts to fish migration, such changes are likely to cause changes in floodplain habitats and to impact very negatively ecosystem productivity, including fish.

Demographic and livelihood changes

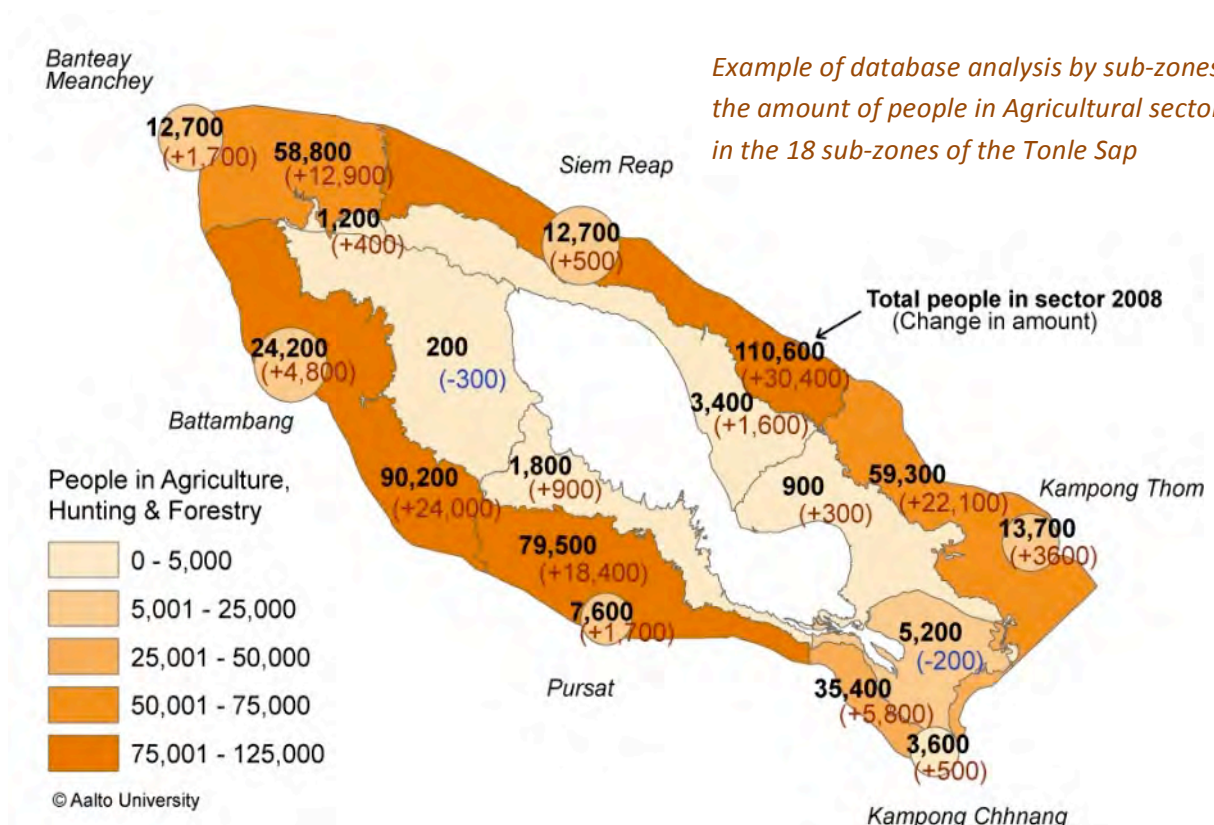
The population growth in the Tonle Sap is still relatively rapid, although slowing down. Cities and their surrounding areas experience particularly rapid population increase due to population growth and migration. Urban areas are the 'engines of change' in the area in many ways. Yet, most people in rural areas seem not be willing to migrate.

The so-called 'youth surge' represents a major influence on the development of the area, but it can also lead to problems if the new work force is not able to engage in meaningful job opportunities.

Related to this, education, infrastructure, markets and private sector development will have an important influence on the development trajectories. It is also important to note that the general levels of education in the area remain low, although improvements are being observed particularly in urban areas.

In terms of livelihoods, the situation in the Tonle Sap has been relatively stable within the past decade (1998-2008). Agriculture dominates very clearly the livelihood activities, although the proportion is slowly decreasing. Yet, population growth has meant that the total number of people in the agricultural sector increased by 130'000 people between 1998-2008 (see the map below). There are also remarkable differences in livelihood development between sub-zones.

Involvement in several smaller sectors such as construction, manufacturing and services has grown rapidly between 1998 and 2008, suggesting increasing livelihood diversification particularly in urban and semi-urban areas. The economic growth and changing livelihood structure of Siem Reap is well visible in the Census data, and the city has attracted an enormous amount of additional work force from the surrounding areas.



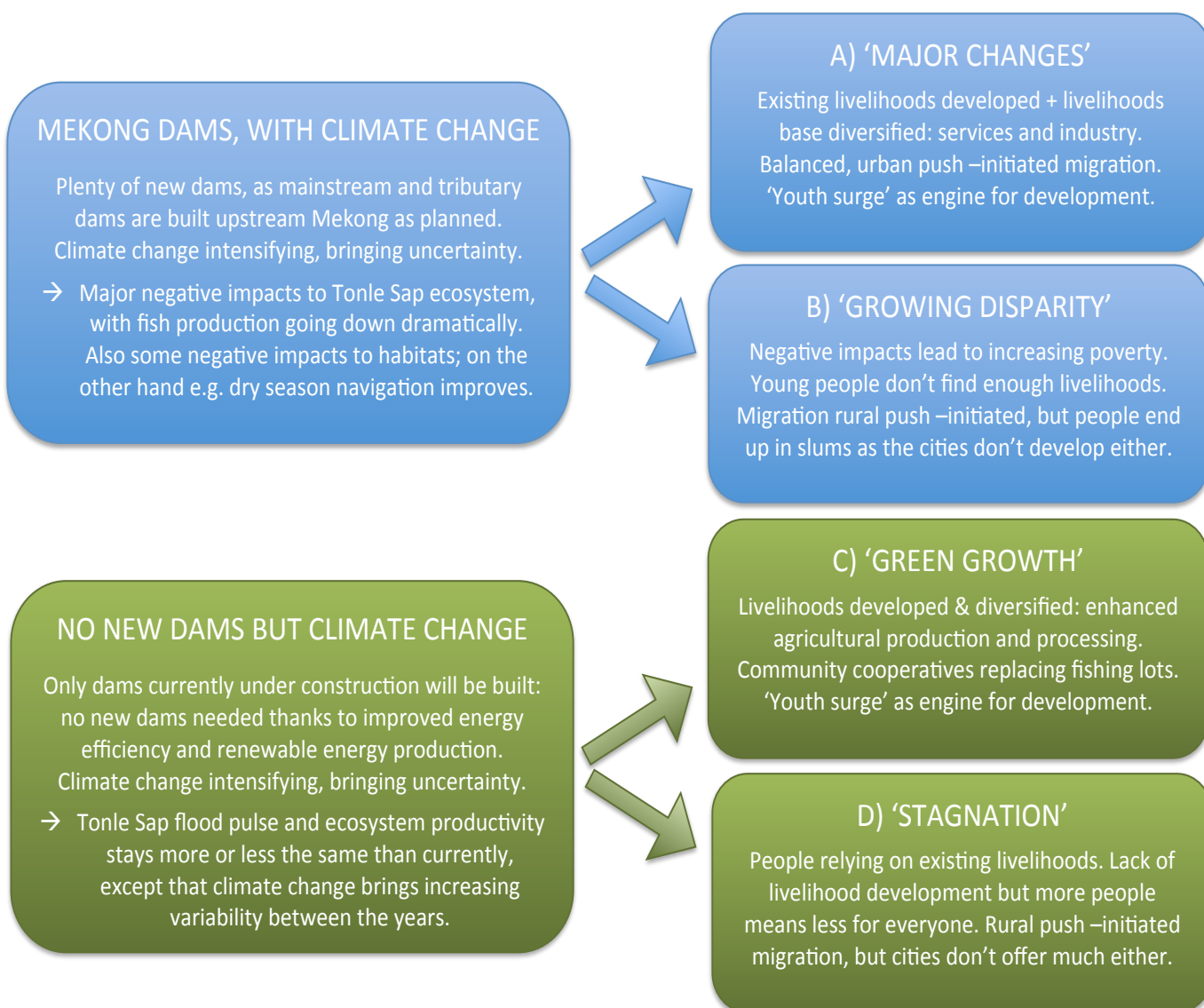
TONLE SAP IN 2040: FOUR ALTERNATIVE FUTURES

How the Tonle Sap will look like by year 2040, when considering the interconnections between water, natural resources and livelihoods as well as diverse demographic, socio-economic and environmental changes?

We synthesised our research findings by creating four alternative futures for the Tonle Sap in 2040, building on water- and livelihoods-related changes and trends that we feel are possible to occur in the area. The alternative futures build on two possible ‘water paths’ (one with plenty of Mekong dams, other with no new Mekong dams) as well as two ‘societal development paths’ (good and not-so-good

socio-economic development). For more, see the figure below as well as the updated figure in our Final Report (Keskinen et al. 2013).

While the development of the Mekong hydropower is largely out of the hands of the Cambodian government, the ‘societal development paths’ are strongly dependent on the implementation –and non-implementation– of the government’s development policies in the area. Hence, we also recognised most relevant policy objectives for the Tonle Sap, building on the Government’s Rectangular Strategy. For more on these, see our Final Report.



DISCUSSION & CONCLUSIONS

The government of Cambodia has naturally a major role for the development of the Tonle Sap area. At regional level, we see that the government should continue active discussions on the most sustainable ways to develop the Mekong's water resources, including hydropower: this is particularly critical in order to maintain the vital fisheries of the Tonle Sap system.

At national level, the Cambodia's Rectangular Strategy incorporates all relevant policies needed for the positive transformations to occur in the Tonle Sap. Putting these ambitious policies into practice is, however, not easy and requires major attention.

At local level it will be important to consider the differences in the current status and future development potential within the Tonle Sap area itself. Our study confirms that the Tonle Sap area can be divided into three distinct 'resource use zones' or 'livelihood zones': Fishing zone, Agricultural zone and Urban zone. Yet, there are also major differences between the 18 sub-zones of this study.

The livelihood structures in the three 'livelihood zones' are very different and have also stayed rather stable within the past decade (1998-2008). Such a finding indicates that any livelihood development in the Tonle Sap area should use the existing livelihood

structure as a basis, building on and extending from it. On the other hand, the vast amount of people entering the work force due to the 'youth surge' suggest that there are also needs for completely new kinds income sources: these are likely to be largely non-agricultural and be mainly developing to the cities and provincial towns.

In agriculture, we see that increasing the agricultural productivity will be particularly important. We also suggest that the provincial capitals could be developed in bit different ways, building on their existing –and partly differing– strengths. Siem Reap with its booming tourism and service sector is a prime example of this. In Fishing zone, the successful implementation of the on-going fisheries reform will be a critical component for the livelihood development. Major efforts are also needed to ensure improvements in general human resources development, including health and education.

The social and economic development of the Tonle Sap has close linkages to land and natural resources and, more broadly, to the so-called water-energy-food nexus. Due to the close linkages between the lake, its natural resources and the people, there is a particular need for active cross-sectoral collaboration between the agencies implementing the relevant policies at different levels.

For more information:

Keskinen, Marko, Matti Kummu, Aura Salmivaara, Paradis Someth, Hannu Lauri, Hans de Moel, Philip Ward & Sokhem Pech (2013). **Tonle Sap now and in the future?, Final Report of the Exploring Tonle Sap Futures study**, Aalto University and 100Gen Ltd. with Hatfield Consultants Partnership, VU University Amsterdam, EIA Ltd. and Institute of Technology of Cambodia, in partnership with Tonle Sap Authority and Supreme National Economic Council. Water & Development Publications WD-11, Aalto University, Espoo, Finland.

For more on Aalto University's Water & Development Research Group: www.wdrg.fi