Riverscope

Case Study: Sambor, Cambodia Summary

TMP Systems | August 2021

INTERNATIONAL RIVERS
people • water • life

TMP SYSTEMS

1. OVERVIEW

The electricity produced by large-scale hydropower is expensive in commercial, social, and environmental terms. Dams have significant and irreversible impacts on societies and ecosystems while being exposed to huge operational and financial risks. Yet, the way that these projects are assessed systematically underestimates these impacts and risks, meaning that investors, developers, and regulators often make the wrong decisions based on incomplete information.

This document summarizes an assessment of the proposed Sambor hydropower project in Cambodia, using the "Riverscope" assessment tool. Riverscope offers a new way to assess large dams by combining geospatial analysis, expert investigation, and financial modeling. Riverscope is unique in that it presents a commercial comparison between hydropower, solar, and wind, alongside a rapid but wide-reaching environmental and social risk analysis. As such, it provides relevant information and analysis for governments, investors, and the third sector. The full assessment report and methodology is available at www.riverscope.org.

This Riverscope assessment of Sambor shows that:.

1. **The project could be delayed by 14 years,** mainly because of a combination of social and environmental challenges. This delay significantly reduces the dam's financial value.

2. Under the most likely scenario, **Sambor will be 50% more expensive than solar by 2039** (the most probable starting date of operation).

3. **Alternative energy technologies could deal with energy poverty and security more cheaply and more rapidly** than Sambor without incurring substantial negative impacts.

SAMBOR

The Sambor dam has had various designs:[1] for this report, we consider the 2,600MW run-of-river scheme, located in Kratie Province of Cambodia,[2] which was the initial design.[3] The financing for Sambor is still unclear but the estimated budget is USD 5 billion.[4] The 2,600MW dam is expected to produce 11,740GWh/a. [5]

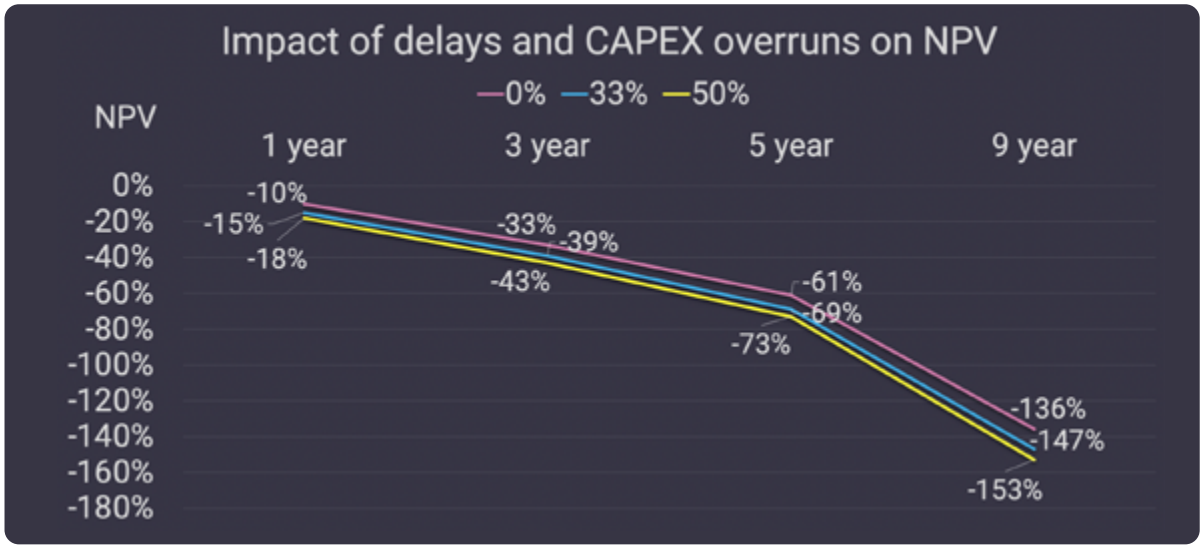
The initial developer, China Southern Power Grid, pulled out in 2011 following local and international pressure. In 2017, the Cambodian Council of Ministers approved a Memorandum of Understanding (MOU) to undertake feasibility and Environmental and Social Impact Assessment (ESIA) studies for Sambor but progress on these have not been forthcoming.[6] The most comprehensive available studies on Sambor to date, carried out by the NHI,[7] have strongly advocated against further development of the dam.[8] The project has not signed an offtake agreement and has been placed under a 10-year moratorium by the Cambodian government.

2.COMMERCIAL ASSESSMENT

Our commercial assessment of Sambor evaluates three key areas of commercial risk: delays and slippage, the Levelized Cost of Electricity (LCOE), and offtake arrangements. In this case, perfect implementation might deliver a competitive project. However, Riverscope shows that cost and time overruns are likely to make Sambor highly unattractive in financial terms.

DELAYS AND SLIPPAGE

Given Cambodia's 10-year moratorium of all mainstream hydropower projects until 2030,[9] under the most favorable conditions, construction will only start in 2030 with operation beginning in 2036. Our analysis based on similar cases suggests further delays are likely and the earliest plausible date of operation will be 2039. As seen in the graph overleaf, further delays and deferred cash flows would lead to a considerable decline in the Net Present Value (NPV).



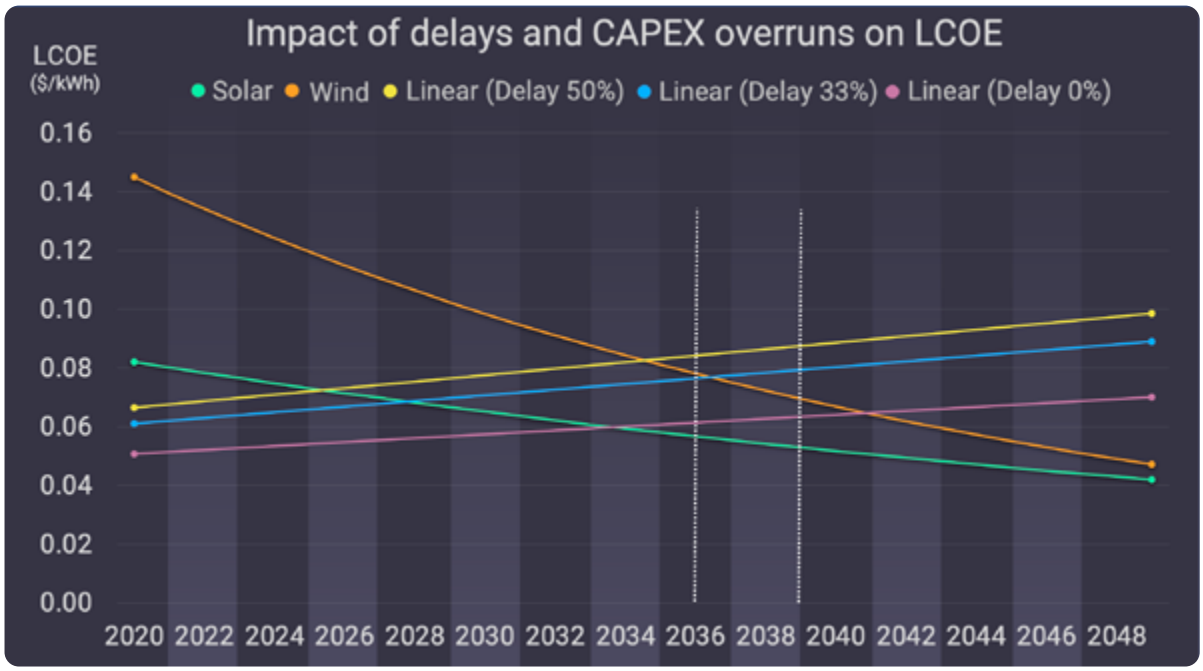
Graph 1. Created by TMP Public

A delay of 2-3 years without overspend translates into a 21%-33% decline in NPV, or a loss of $0.78 - $1.12 billion, respectively. A similar delay with typical overspend (33%) translates into losses of $0.95-$1.28 billion.

LEVELIZED COST OF ELECTRICITY (LCOE)

The investment case for Sambor appears to be weak, particularly when compared to locally available alternative energy investments. We demonstrate the commercial superiority of local solar and wind projects by comparing the LCOE of Sambor with representative local values.

The graph below shows how the competitiveness of Sambor deteriorates in proportion to delay it experiences. In 2036, the earliest possible start date, the dam may be cheaper than wind, but is already 7% more expensive than solar. By 2039, the likely start date, solar is considerably cheaper (19%), and wind is competitive. If we assume that Sambor also experiences the budget overruns that are typical for hydropower projects (33%[10]), then the dam will be 35% more expensive than solar in 2036 and a similar price to wind.



Graph 2. Created by TMP Public

OFFTAKE ASSESSMENT

The COVID-19 pandemic is likely to reduce electricity demand in Southeast Asia, which risks becoming saturated with competitive options.[11] Sambor has not yet secured a power purchase agreement (PPA) from Vietnam, which seems focused on domestic energy production[12] and may prove unsupportive given Sambor's expected impacts on the Mekong Delta. Sambor is further exposed on the offtake side because it will need to transport electricity over long distances which, in turn will require new or upgraded infrastructure. These transmission lines are likely to create further delays.

3. ENVIRONMENTAL RISK ASSESSMENT

This section summarizes the environmental risks for Sambor, which undermine the investment case. The large environmental risks associated with dams are hard to manage or avoid. Resulting controversies and measures taken by developers to deal with them hamper implementation and increase costs.

These results suggest that the project area and wider region is rich in biodiversity highlighting an extreme sensitivity to change. High sediment loads help to sustain such diversity and Sambor will have particularly significant impacts in the immediate areas and downstream. High scores for Protected Areas and local cropland suggest that this is a remote and sensitive area that is unsuitable for a project like Sambor.

INDICATOR	SCORE			COMMENT
	DAM	RIVER	DISTRICT	
Water Scarcity	57	59	59	Cambodia is water-rich, but water scarcity could still be an issue as reflected in recent droughts.
Sediment Flux	98	99	97	Local sediment flow is extremely poor and will be further affected, which could damage biodiversity, fisheries, farms and water quality downstream.
Species Richness	97	94	98	This area is very rich in biodiversity. The whole river is a Key Biodiversity Area which is threatened by Sambor.
Inter-Annual Variability	2	2		This low variability is typical in tropical contexts, but this may now be upset by climate change.
Upstream Drainage	97	95		The area around the dam is poorly suited for catching rain and providing water downstream.
Protected Areas			92	Protected areas are very common around the dam, increasing risks to local biodiversity.
% Irrigated Cropland			65	The high score represents low levels of cropland: dams seem to have greater problems in remote areas relatively untouched by development.
Drought Severity			17	This low score is based on historical data. The recent drought suggests future challenges.

A woman selling fish at a local market in Sambor district, Kratie province, Cambodia. Photo by International Rivers.

BIODIVERSITY

Sambor will block many migratory fish species and disrupt the spawning habits of several iconic Mekong species, which may constitute an extinction event for the Irrawaddy Dolphin.[13] Sambor is planned on a stretch of the Mekong that experiences one of the largest annual fish migrations in the world.[14]

The NHI have indicated that a fish passage for a dam as high as Sambor's dam is simply not possible. Even in better conditions, fish survival rates from real fish passage installations do not exceed 55%.[15] Sambor therefore seems very likely to have a catastrophic effect on aquatic biodiversity in the Mekong.

WATER MANAGEMENT

Hydropower dams disrupt natural sediment and water flows[16], which are crucial for supporting the Mekong's rich biodiversity and ecosystem services.[17] These impacts on sediment flow cannot be mitigated, which means that Sambor would capture all bedload and 60% of suspended sediments,[18] which otherwise maintain and replenish the Mekong Delta in Vietnam.[19]

Sambor would also have the largest inundation area of all mainstream dams in the Lower Mekong Basin (LMB) and would disrupt the Mekong's natural flooding and flow cycles. These cycles are essential for providing water and nutrients to the Mekong's surrounding croplands and river systems downstream.[20]

CLIMATE

Hydropower is exposed to climate change impacts on water availability and droughts, which will reduce energy production. The current regional drought, combined with upstream hydropower interference, has directly impacted Cambodia[21] and the power outputs of existing hydropower generation, demonstrating its vulnerability as a primary energy source.[22]

Sambor's reservoir, expected to extend 82km upstream and 620 km^2,[23] will likely generate greenhouse gas emissions,[24] as is common in tropical regions.[25] Accelerated eutrophication already threatens Cambodia.[26]

CUMULATIVE ENVIRONMENTAL IMPACTS

Sambor and other hydropower dams on the mainstream and tributaries will trap sediments, disrupt fish migrations and alter flow regimes, and, according to the Mekong River Commission (MRC), overshadow impacts of all other planned water resource developments in the LMB.[27] Fish populations and catch could fall by 40% to 80% by 2040.[28] It could destroy the Mekong fishery altogether.

4. SOCIAL RISK ASSESSMENT

This social assessment of Sambor focuses on three key drivers of social risk: food security, relocation, and socio-economic tensions, and political risks.

The results below suggest that the area is poor and under-resourced, with little experience of large-scale economic development. Gaining informed consent is therefore likely to be hard, and the risk of escalating disputes is high. The lack of access to necessities like food, water, and schooling make the area highly exposed to the social impacts that are expected with Sambor.

INDICATOR	SCORE			COMMENT
	DAM	RIVER	DISTRICT	
% Deprived: Sanitation	62	65	59	Local people lack access to basic services and similar government support.
% Deprived: Drinking Water	87	83		Disruptions to the quantity or quality of water resources, upon which locals depend, will create opposition.
% Deprived: Schooling	86	83		Low levels of schooling in this area increase the risk of dispute or conflict.
Multidimensional Poverty Index	81			Extreme socio-economic vulnerability increases the risk of dispute.
Vulnerability to Poverty	75			Project-related disruptions could tip local people into severe poverty, increasing the risk of dispute significantly.
Population Density		39		These scores suggest low population densities. This remote area has little experience with development and is higher risk as a result.
Night Lights		79		
Conflict			16	The area has experienced little disruptive events.

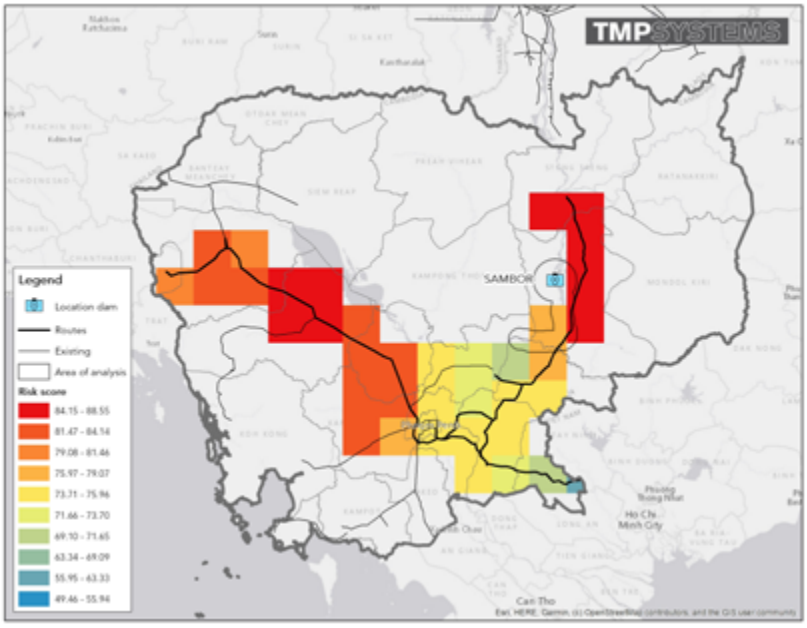
FOOD SECURITY

By 2030, Sambor could reduce yields of fish and other aquatic animals by 16%-30% from a 2011 baseline.[29] Rural poverty and food insecurity are strongly interlinked in Cambodia. Most people rely on subsistence farming and fishing as key sources of food and livelihood security. Fisheries contribute up to 75% of animal protein consumed in Cambodia.[30] Cambodia's Tonlé Sap Lake and surrounds supports an approximate 1 million local fishers and farmers in the area,[31] with 40% of households relying almost entirely on the fishery for income.[32] Sambor will negatively affect fisheries and croplands locally and across borders, including down to the Mekong Delta.[33]

RELOCATION AND SOCIO-ECONOMIC TENSIONS

Sambor has been predicted to relocate at least 19,000[34] - 20,000[35] local residents, while our own calculations[36] suggest 252,626 people could be directly affected. Affected people have said they "don't want to move" and "don't want compensation"[37] that has proved inadequate for the Lower Sesan 2 dam.[38] People have already organised against Sambor, contributing to the withdrawal of China Southern Power Grid.[39]

The extensive transmission infrastructure required for Sambor may drive further displacement and conflict, which could delay the dam. Our risk score for these transmission lines (see graphic below) was extremely high, so dispute and lengthy delays seem likely (e.g. north of Sambor).



Map created by TMP Public

POLITICAL RISK ASSESSMENT

Corruption in Cambodia runs deep,[40] which may explain support for Sambor. Cambodia's recent moratorium suggests the tide of political opinion may be turning and so risk may be growing for the dam. The Cambodian government and CSOs have voiced concerns over Laos' continued pursuit of upstream dams and will have to abandon Sambor to apply real pressure.[41] Sambor's likely impacts on Vietnam are also a concern for regional politics.

CUMULATIVE SOCIAL IMPACTS

Proposed hydropower dams on the Mekong mainstream could drive economic losses in excess of USD 7.3 billion, with a 30% loss of Cambodia's and Laos' annual protein intake.[42] These cumulative food security threats could affect upwards of 2.1 million people in Laos and Cambodia.[43] Sambor adds to threats to national food security and regional livelihoods. Despite Cambodia's concerns over the cumulative impacts of Laos dams, neither Sambor nor Stung Treng have officially been cancelled.

5. ALTERNATIVES

Alternatives have considerable benefits from a commercial, environmental, and social perspective relative to hydropower, despite potential storage, grid, and tariff challenges.

COMMERCIAL PERSPECTIVE

Solar and wind can provide peak or base power to the grid or within a grid-tied, mini- or off-grid system and so provide a financially viable way to decentralize electricity production and rapidly meet domestic and export energy demand. Cambodia has plenty of potential in areas with lower social and environmental risks than Sambor.

ENVIRONMENTAL PERSPECTIVE

Alternatives could have little impact on the Mekong's aquatic biodiversity and can also be located nearer to demand, reducing the need for long transmission lines. Solar and wind technologies are more spatially

efficient than hydropower[44], reducing land-based disruptions. Co-production models and innovative approaches like floating solar can reduce energy's hunger for land without undermining the commercial case for alternative energy investments. Floating solar would not disrupt an already-threatened Mekong system in the same way as would new dams[45], while solar and hydropower integration also enables more consistent energy production.[46]

SOCIAL PERSPECTIVE

The decentralized renewable energy sector can be developed rapidly within or close to communities. This flexibility can distribute the benefits of energy investment more easily and evenly, while reducing resettlement. Solar can deliver more jobs than hydropower, too. The Lower Sesan 2 Dam was estimated to create 3,000 construction jobs,[47] while a planned solar farm has created the same amount of jobs to deliver less than half the capacity – so double the jobs per megawatt for cheaper electricity.[48]

Mekong River, Sambor district, Kratie province, Cambodia.

6. SUMMARY AND RECOMMENDATIONS

Sambor does not make sense on commercial, economic, or social grounds. Current plans are expensive and have an unacceptable environmental cost. Sambor is unlikely to operate until 2039, at which point it will be 50% more expensive than solar.

Our assessment shows that hydropower is not the right technology to deliver energy access to Cambodia. Governments and international financial institutions can create an enabling environment for alternatives by offering them the same sort of concessional finance awarded to hydropower. Clear and well-planned government support for large scale roll out of alternatives can help to stimulate the sector.

RECOMMENDATIONS FOR FINANCIERS AND INVESTORS:

- **Review the investment case for Sambor in the context of lengthy delays, regional opposition, high reputational risks and COVID-19** (both in terms of further delay and reduced demand for energy). Adjust the approach to financial modeling for projects like Sambor using Riverscope. Compare the investment case for Sambor to alternatives.
- **Demand higher social and environmental standards from developers** to improve impact and mitigate risk. Work with the developer on the above recommendations.

RECOMMENDATIONS FOR GOVERNMENT:

- At minimum, **cooperate with efforts to establish up-to-date baselines for the project and to understand the cumulative and transboundary impact of hydropower development along the Mekong.** Compare the capacity of Sambor to create foreign exchange relative to similar investments in alternatives.
- **Demand high social and environmental standards from developers**. Consult developers of alternatives to understand how to de-risk investments in them.

ENDNOTES

1. https://etd.ohiolink.edu/apexprod/rws_etd/send_file/send?accession=kent1492958383715333&disposition=inline
2. https://icem.com.au/documents/envassessment/mrc_sea_hp/SEA_Final_Report_Oct_2010.pdf
3. https://www.internationalrivers.org/wp-content/uploads/sites/86/2020/06/mekongmainstreamdamsupdatejune2017_english.pdf
4. https://news.mongabay.com/2017/03/cambodias-sambor-dam-plans-cause-controversy-as-public-left-in-the-dark/
5. https://icem.com.au/documents/envassessment/mrc_sea_hp/SEA_Final_Report_Oct_2010.pdf
6. https://english.cambodiadaily.com/news/kith-meng-backs-plans-for-three-hydropower-dams-124528/
7. The Natural Heritage Institute (NHI) studies were conducted for the Cambodian government by an international team of technical experts together with various relevant Cambodian ministries over five years. That such a government-backed assessment has concluded to defer any further commitments to Sambor is significant and will very likely play a critical role in further project delays, if not an altogether cancellation of the project.
8. https://data.opendevelopmentmekong.net/dataset/4f1bb5fd-a564-4d37-878b-c288af460143
9. https://www.theguardian.com/world/2020/mar/20/cambodia-scraps-plans-for-mekong-hydropower-dams
10. https://www.tandfonline.com/doi/full/10.1080/07900627.2019.1568232
11. https://www.iea.org/reports/electricity-market-report-december-2020/2020-regional-focus-southeast-asia
12. Over 30,000 rooftop solar systems were rolled out in Vietnam in December 2020 alone, with a total of over 105,00 systems installed at a generation capacity of approximately 9,700MWp https://vepg.vn/wp-content/uploads/2021/02/VEPG_RTS_Factfile_Dec_2020_EN_fin.pdf
13. https://www.worldwildlife.org/species/irrawaddy-dolphin
14. https://data.opendevelopmentmekong.net/dataset/sambor-hydropower-dam-alternatives-assessment-final-report/resource/fed94672-dc65-4571-a953-15fa544be213
15. https://data.opendevelopmentmekong.net/dataset/4f1bb5fd-a564-4d37-878b-c288af460143/resource/a2dc0ce6-f0fd-4688-94ab-6996a801a239/download/volume-1_executive-summary.pdf
16. Sediment flow refers to the transport of a combination of organic and inorganic materials that can provide key nutrients to riverine ecosystems and aquatic species, and can also affect the morphology of river systems

ENDNOTES

17. https://www.stimson.org/2020/2020-status-of-lower-mekong-mainstream-and-tributary-dams/
18. https://data.opendevelopmentmekong.net/dataset/4f1bb5fd-a564-4d37-878b-c288af460143/resource/a2dc0ce6-f0fd-4688-94ab-6996a801a239/download/volume-1_executive-summary.pdf
19. https://data.opendevelopmentmekong.net/dataset/4f1bb5fd-a564-4d37-878b-c288af460143/resource/fed94672-dc65-4571-a953-15fa544be213/download/cambodia_key-findings-of-sambor-assessment_updated-11-mar-2018.pdf ; https://www.researchgate.net/publication/325311598_Evaluation_on_the_impacts_of_Hydropower_Development_on_Salinity_Intrusion_into_Vietnamese_Mekong_Delta
20. https://www.mrcmekong.org/assets/Publications/Consultations/SEA-Hydropower/SEA-Main-Final-Report.pdf
21. https://foreignpolicy.com/2020/04/28/in-the-mekong-a-confluence-of-calamities/
22. https://www.globaldata.com/cambodia-reduce-reliance-hydropower-developing-coal-solar-capacities-2020-30-says-globaldata/
23. http://d2ouvy59p0dg6k.cloudfront.net/downloads/sambor___stung_treng_brief_wwf.pdf
24. Hydropower dam reservoirs lead to eutrophication through the build-up of nutrients, promoting excessive algal growth and oxygen-depleted waters. The further decomposition of this algae in addition to the plants and trees in the inundation area, results in both methane and carbon emissions, respectively. Algae, phytoplankton and associated aquatic plants create 'methane factories', which remove CO2 from the atmosphere and return methane when they die. This has a much greater impact on the environment.
25. https://onlinelibrary.wiley.com/doi/epdf/10.1002/clen.200900062
26. https://link.springer.com/chapter/10.1007/978-90-481-9625-8_19
27. https://www.mrcmekong.org/assets/Publications/Council-Study/Council-study-Reports-discipline/CS-Key-Messages-long-v9.pdf
28. http://www.mrcmekong.org/assets/Publications/Council-Study/Council-study-Reports-discipline/CS-Key-Messages-long-v9.pdf
29. Although this study was carried out before the current mainstream hydropower delays in Cambodia, it nevertheless reveals the significant negative impacts that Sambor would have for food security in the region http://pubs.iclarm.net/resource_centre/IFReDI.2013.Mainstream-dams-and-nutrition-in-Cambodia.pdf
30. https://www.iucn.org/news/viet-nam/201906/mekong-transboundary-cooperation-making-a-problem-bigger
31. https://www.nationalgeographic.com/science/2020/08/cambodia-tonle-sap-lake-running-dry-taking-flooded-forest-fish/
32. https://www.scirp.org/journal/paperinformation.aspx?paperid=84296
33. https://www.nature.com/articles/s41598-020-64630-z
34. https://icem.com.au/documents/envassessment/mrc_sea_hp/SEA_Final_Report_Oct_2010.pdf

ENDNOTES

35. http://d2ouvy59p0dg6k.cloudfront.net/downloads/sambor___stung_treng_brief_wwf.pdf
36. Our calculations used the Gridded Population of the World (GPWv4) database.
37. https://www.scmp.com/news/china/diplomacy-defence/article/2139751/are-chinese-funded-dams-mekong-river-washing-away
38. https://static1.squarespace.com/static/575fb39762cd94c2d69dc556/t/5932eea5893fc0ac542c8909/1496510120987/No.16_P366_398_Suon+Siny.pdf ; https://www.researchgate.net/publication/335318445_INTERNATIONAL_JOURNAL_FOR_INNOVATIVE_Impact_of_Communities'_Livelihood_Resulting_from_Lower_Sesan_2_Hydropower_Dam's_Resettlement_Project
39. https://news.mongabay.com/2017/03/cambodias-sambor-dam-plans-cause-controversy-as-public-left-in-the-dark/
40. Cambodia ranked 160 out of 180 countries worldwide, the lowest in the region, according to Transparency International's latest 2020 Corruption Perceptions Index report https://images.transparencycdn.org/images/CPI2020_Report_EN_0802-WEB-1_2021-02-08-103053.pdf
41. https://uk.reuters.com/article/us-mekong-river-dam/laos-to-move-on-third-mekong-dam-project-despite-neighbours-green-concerns-idUKKBN2425MC
42. https://www.mdpi.com/2071-1050/12/6/2408
43. Between 60% and 95% of rural households in the countries of Laos, Cambodia, and Vietnam are directly involved in fishing and farming, but fish remains the main source of protein (https://www.mdpi.com/2071-1050/12/6/2408/pdf)
44. Solar and wind have been shown to use far less land per megawatt produced than hydropower, with approximately 17.6ha/MW and 28.6ha/MW, respectively, versus 127.5ha/MW for hydropower (https://www.strata.org/pdf/2017/footprints-full.pdf)
45. https://data.opendevelopmentmekong.net/dataset/4f1bb5fd-a564-4d37-878b-c288af460143/resource/a2dc0ce6-f0fd-4688-94ab-6996a801a239/download/volume-1_executive-summary.pdf
46. https://data.opendevelopmentmekong.net/dataset/4f1bb5fd-a564-4d37-878b-c288af460143/resource/a2dc0ce6-f0fd-4688-94ab-6996a801a239/download/volume-1_executive-summary.pdf
47. https://wle-mekong.cgiar.org/download/all/mk4-water-governance/MK4_Dam%20Management%20and%20Livelihoods%20Cambodia_Document.pdf
48. https://www.phnompenhpost.com/business/massive-solar-farm-planned-us-firm

Cover Image: A cozy view of a riparine community in Sambor, Kratie.