Rethinking Renewables in the Mekong Basin

Opportunities and Challenges for a Transboundary Renewables-Based Power Grid in the Lancang-Mekong Region

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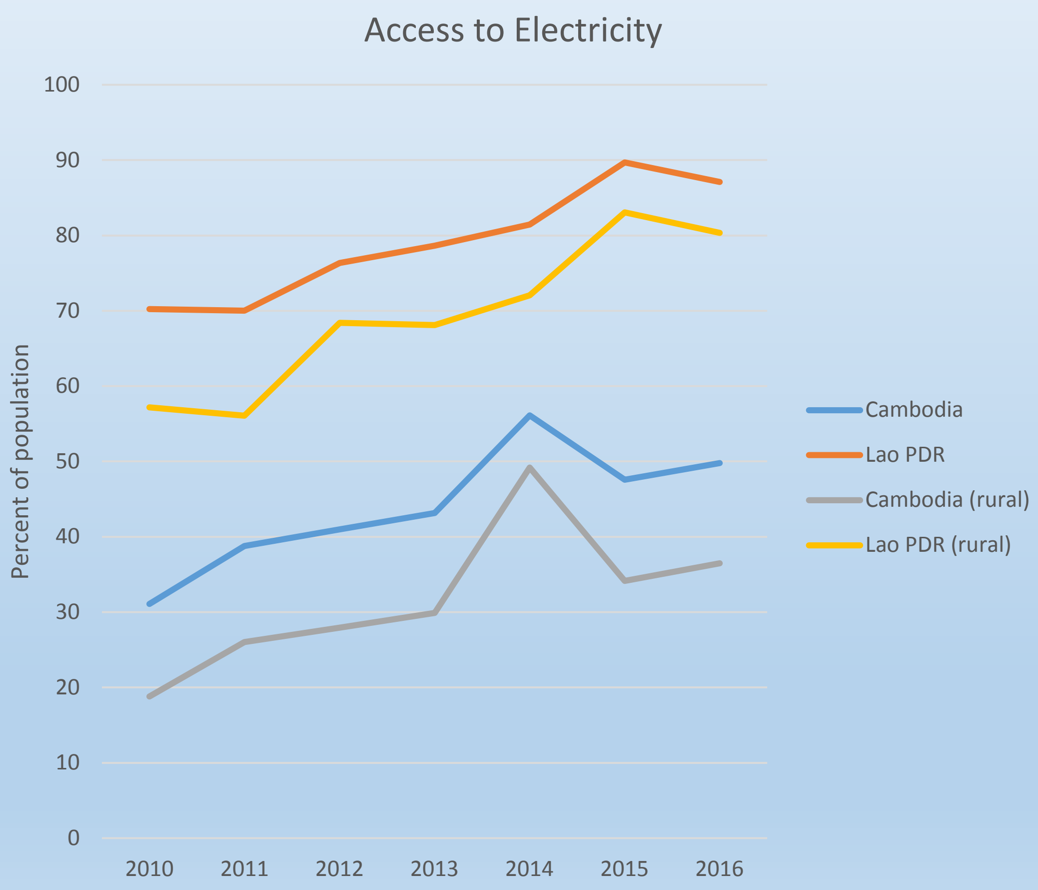
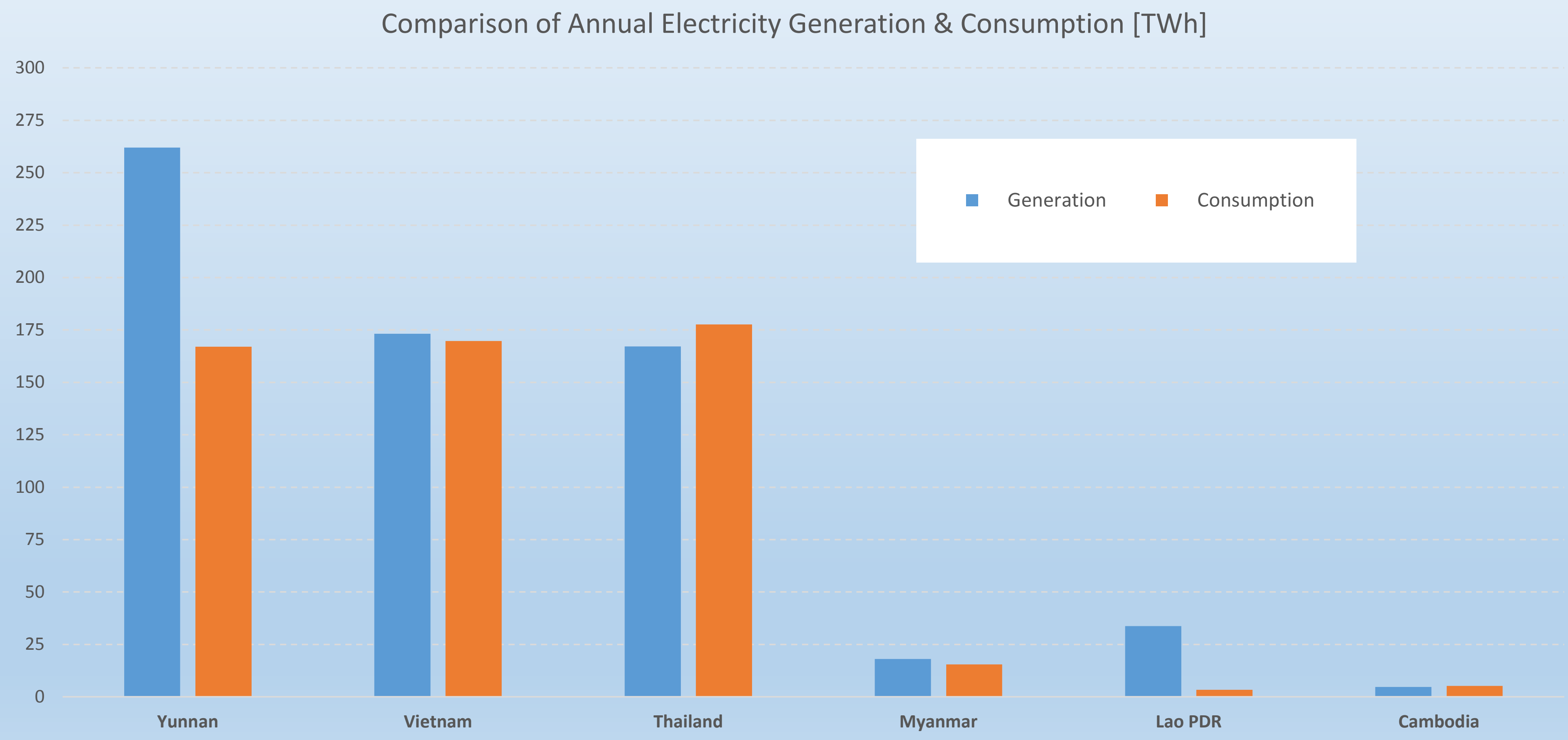
The Mekong region has an electricity problem

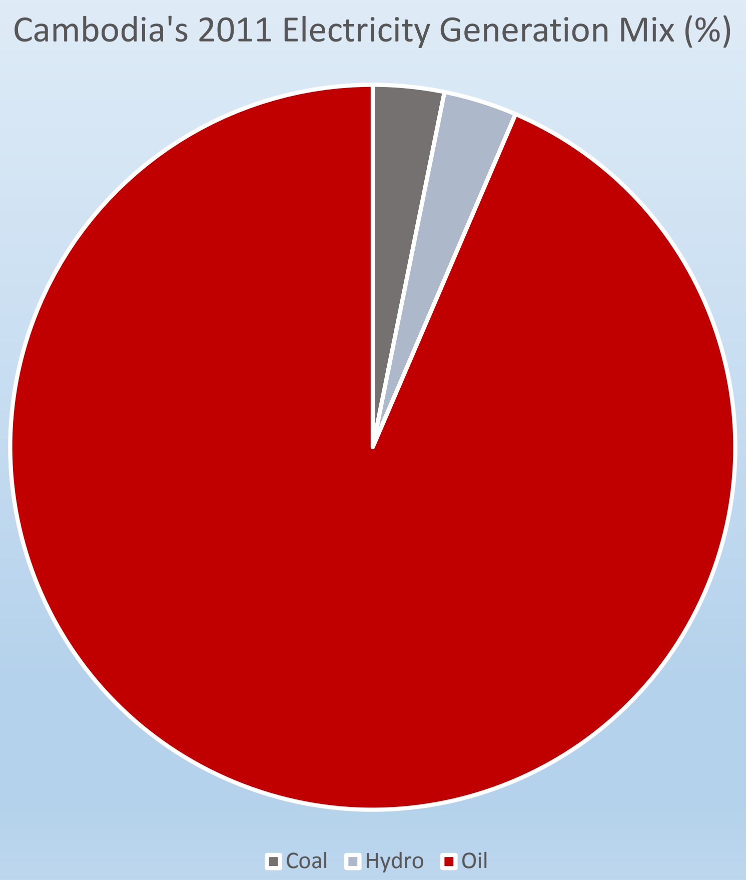
- Cambodia's electricity situation is improving but still fragile
- Numerous isolated grid systems
- Rural-urban disparities persist
- Demand growth outpacing supply growth
- Prices high, reliability low
- Diesel's share of electricity generation has drastically declined in recent years

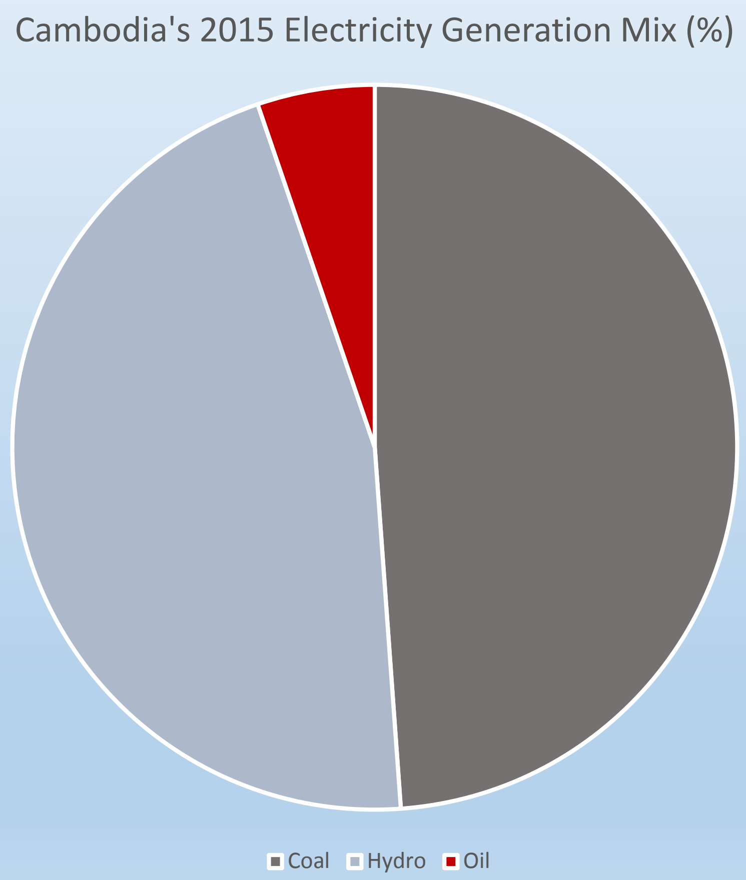


Downstream electricity use low but growing



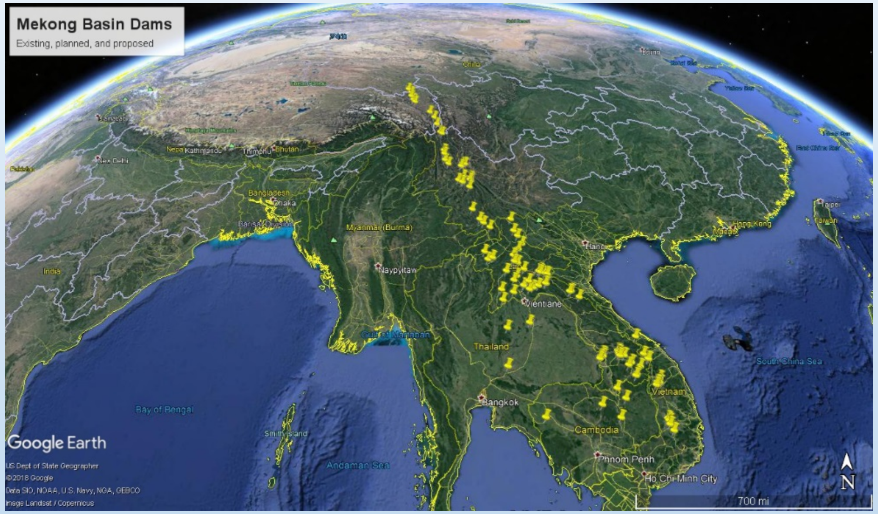
Despite changes, fossil fuels still play key role



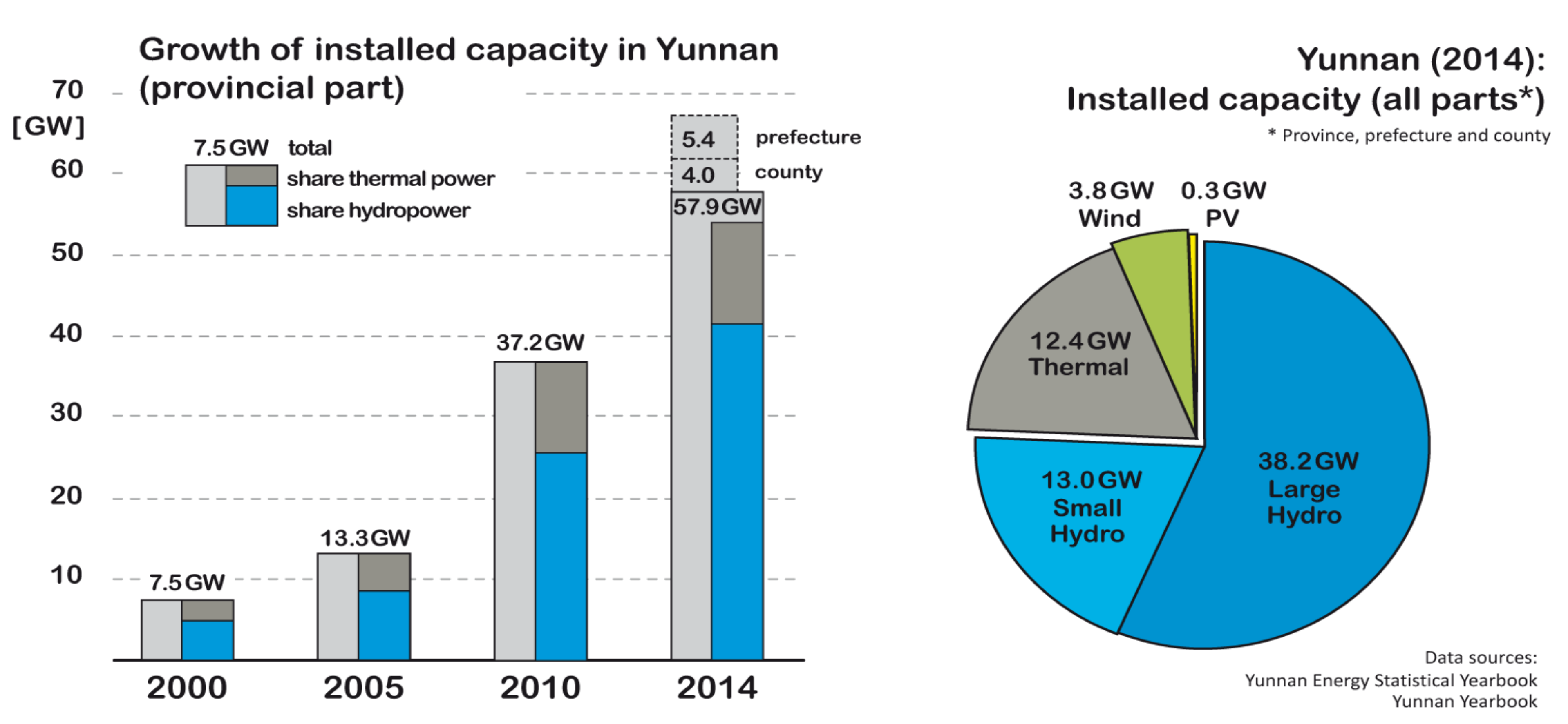


China's energy companies have a solution

- China holds world's greatest hydropower potential and abundant dam experience
- Southwestern China's Yunnan Province already has more installed hydro than Russia, India, Norway and Switzerland
    - ~ ¼ of Lancang-Mekong lies in Yunnan
- Since 2000, Chinese energy SOEs have been encouraged to "go outward" and seek overseas development projects
- BRI/OBOR strengthens that trend

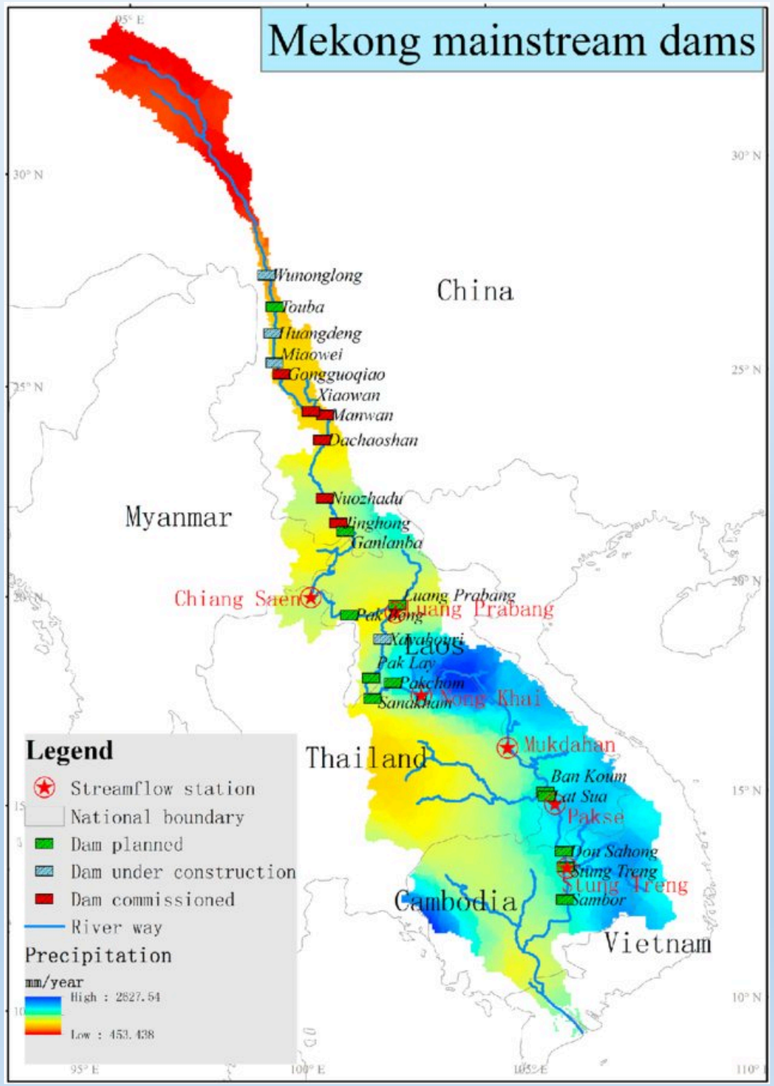


Yunnan Hydro: ~800% growth 2000-2014



Source: Hennig, T., W. Wang, D. Magee, D. He (2017), "Yunnan's fast-paced large hydropower development: A powershed-based approach to critically assessing generation and consumption paradigms"

Dams large and small have a mixed record



- Developers: flood control benefits, electricity
- Local officials: poverty alleviation
- Hydro's fast ramp rate and ability to store renewable energy area its greatest asset
  - With smart grid, hydro can "firm" variable intermittent renewables like wind and solar
- Flood control capacity and power generation capacity vary inversely at any given time

Map source: Wang, W., Lu, H., Leung, L. R., Li, H.-Y., Zhao, J., Tian, F., Yang, K., & Sothea, K. (2017). Dam construction in Lancang-Mekong River Basin could mitigate future flood risk from warming-induced intensified rainfall. Geophysical Research Letters, 44. https://doi.org/10.1002/2017GL075037 (16).

Negative impacts of dams can be synergistic

- Negative socioeconomic, biophysical, and geopolitical impacts are well known (Tullos et al. 2009; Kibler & Tullos 2013)
  - Small is not always better
- Cascade impacts poorly understood
- High food security concerns in MSEA
- Institutions are manifold and weak
- Resettlement outcomes are often poor

Tullos, Desiree, Bryan Tilt, and C. Reidy. 2009. "Introduction to the special issue: Understanding and linking the biophysical, socioeconomic and geopolitical effects of dams." *Journal of Environmental Management 90 (Supplement 3):S203-S207.*

Snapshot of Negative Impacts

- Biophysical
  - Reservoirs trap sediment, flatten the hydrograph, reduce water quality, disrupt ecosystems, waterlog soils, and encourage methane production from rotting submerged biomass
- Socioeconomic
  - Resettlement disrupts social networks and frequently involve inadequate compensation; migrants often lack skills to integrate into new communities; large reservoirs often disrupt local power systems (small hydro on tributaries)
- Geopolitical
  - Institutions for trans-boundary basin governance (even domestically) are limited, and of limited efficacy; regional distrust heightened by lack of transparency
- Impacts can be acute and far-reaching, upstream and downstream

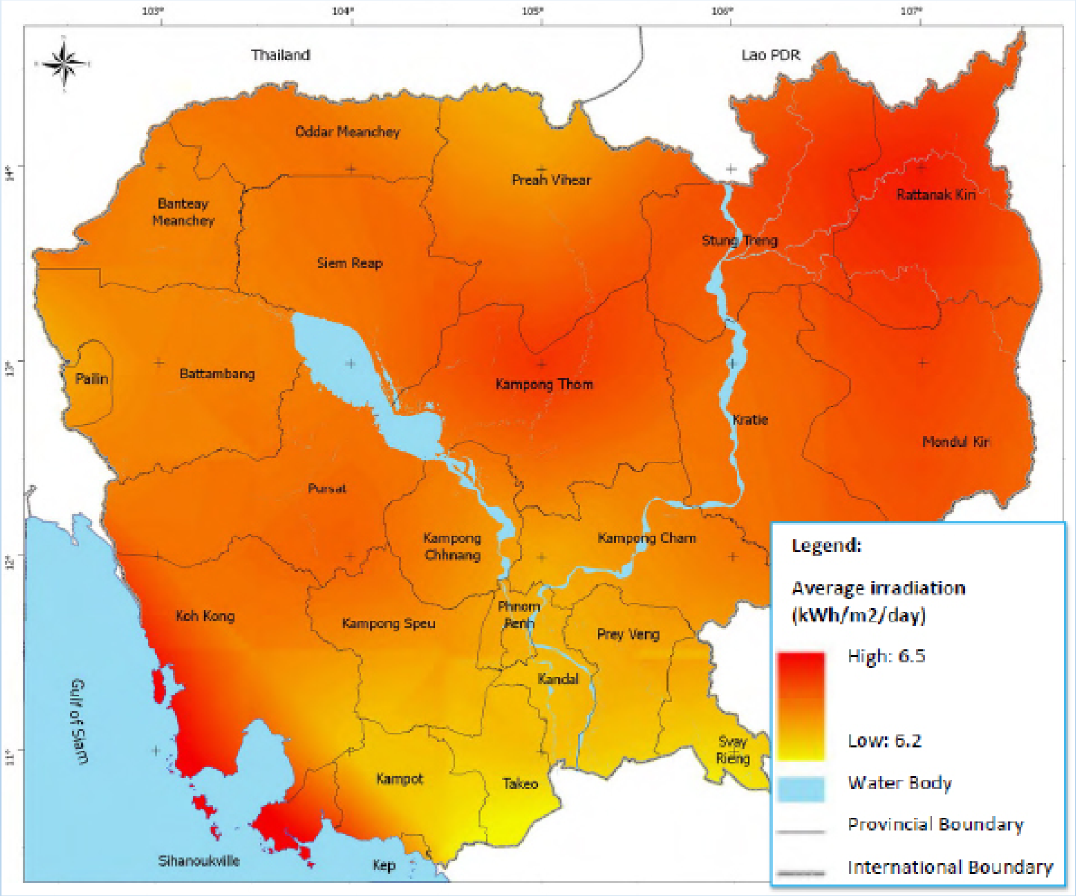
Assessing and Modeling Dam Impacts

Biophysical	**Socioeconomic**	**Geopolitical**
BP1: Water Quality	SE1: Social Capital	GP1: Basin Population Affected
BP2: Biodiversity	SE2: Cultural Change	GP2: Political Complexity
BP3: Sediment	SE3: Local Hydropower Access	GP3: Legal Framework
BP4: Natural Flow Regime	SE4: Health Impacts	GP4: Domestic Governance
BP5: Climate and Air Quality	SE5: Income	GP5: Political Stability (intranational)
BP6: Landscape Stability	SE6: Wealth	GP6: Political Stability (international)
BP7: Impact Area	SE7: Macro Impacts	GP7: Impact on non-basin stakeholders

Integrated Dam Assessment and Modelling project (IDAM) captures positive and negative magnitude of each impact, as well as its salience, to facilitate comparing different scenarios and stakeholder perspectives. *(NSF Grant BCS-0826771)*

Cambodia: Strong solar potential, weak grid

- Population: 15 million
- Annual Electricity Consumption (2015): 5 Billion kWh
- Strong policy support for regional grid integration
- Low electrification rates, high tariffs
- High solar potential: 5 kWh/day/m^2
  - 183 km^2 of solar panels could meet country's current electrical needs (=1/15 Tonle Sap area in dry season)
- High economic growth rates in spite of electricity limitations and costs



Can northern Europe interlink be a model?

- Denmark (Pop. 5.7M)
  - Annual Electricity Consumption (2015): 32 Billion kWh
  - ~50% renewable electricity; 40% of total demand met by wind
  - Wind generation has exceeded demand in the past
- Germany (Pop. 82 M)
  - Annual Electricity Consumption (2015): 536 Billion kWh
  - Roughly 30% renewable electricity, commitment to phasing out nuclear power
  - Dispatch priority for renewables
- Norway (Pop. 5.3 M)
  - Annual Electricity Consumption (2015): 119 Billion kWh
  - 623-km 1400-MW HVDC cable to Germany will allow Norway’s hydropower to balance Germany’s intermittent renewables by 2020
- Norway and Yunnan can be the batteries for high-solar and high-wind neighbors

Challenges are Real but Manageable

- Limited transboundary transmission capacity at present
- Wholesale market undeveloped
- Generator scheduling and dispatch rules need to be more transparent
  - Prioritize lowest cost? Lowest carbon? Balancing vs base load?
  - Balancing w/hydro may require re-regulation to meet downstream flow needs
- Regional mistrust among upstream-downstream countries is real
- Negative impacts of dams are often geographically concentrated
- Positive impacts are often geographically diffuse

Concluding Thoughts

- If we don’t measure the things we value, we end up valuing the things we measure
  - Food security, biodiversity, are geopolitical stability are hard to measure
  - Regulating capacity and generating capacity are easy to measure
  - Electricity output is a crude proxy for the actual services we value that are provided by electricity
- How might state and non-state actors best promote energy development scenarios that sustain ecosystems and livelihoods, while meeting key development indicators?

My favorite China electricity story

- Or, how many light bulbs does it take to change China?
- Incandescent bulb phase-out by 2020
  - LEDs ~12x more efficient
  - 5 W vs 60 W, same light output
  - 55 W saved at bulb = 5500 W at power plant
- Efficiency Power Plants (EPP, 能效电厂)
  - "Changing light bulbs" at utility-scale (MW)
  - Pumps, fans, lighting, transformers, HVAC
- China Energy Research Institute
  - LEDs could save 85 billion kWh/yr
  - Roughly equals annual output of Three Gorges Dam