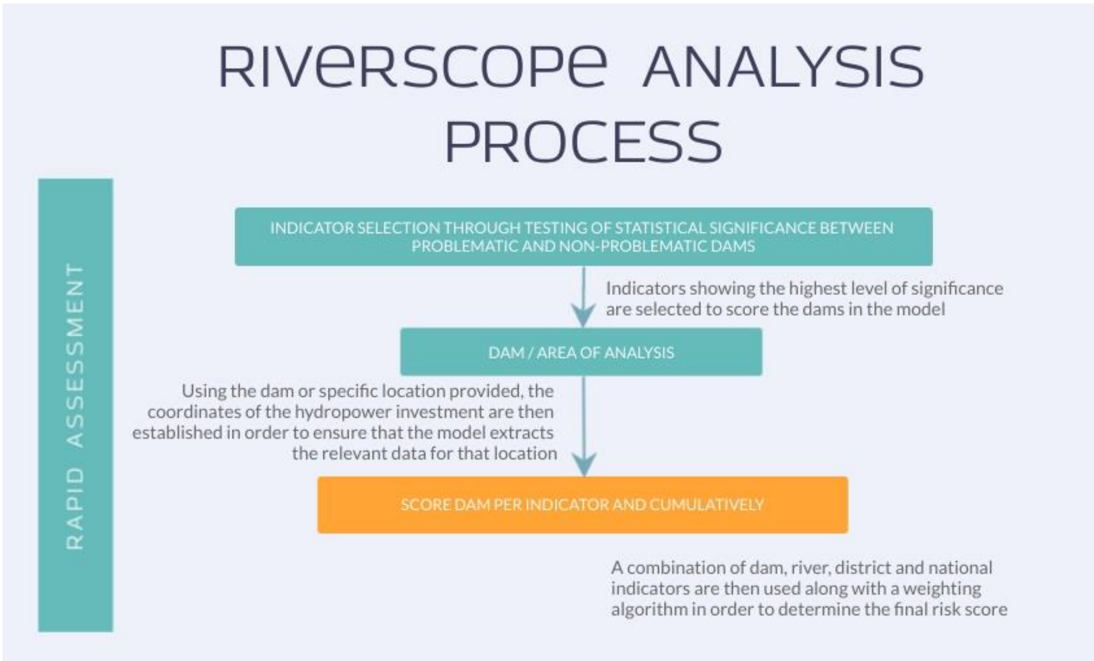
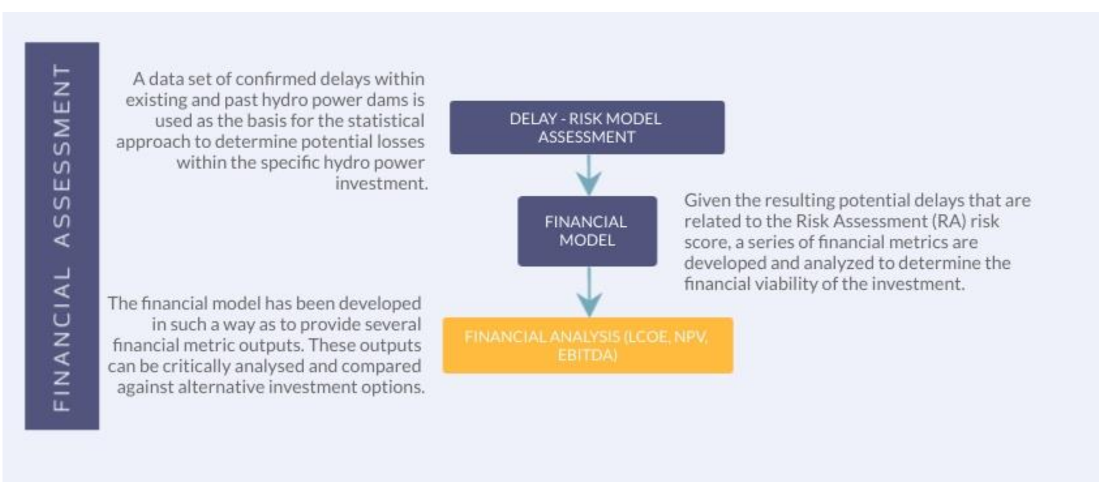
Riverscope assessment process

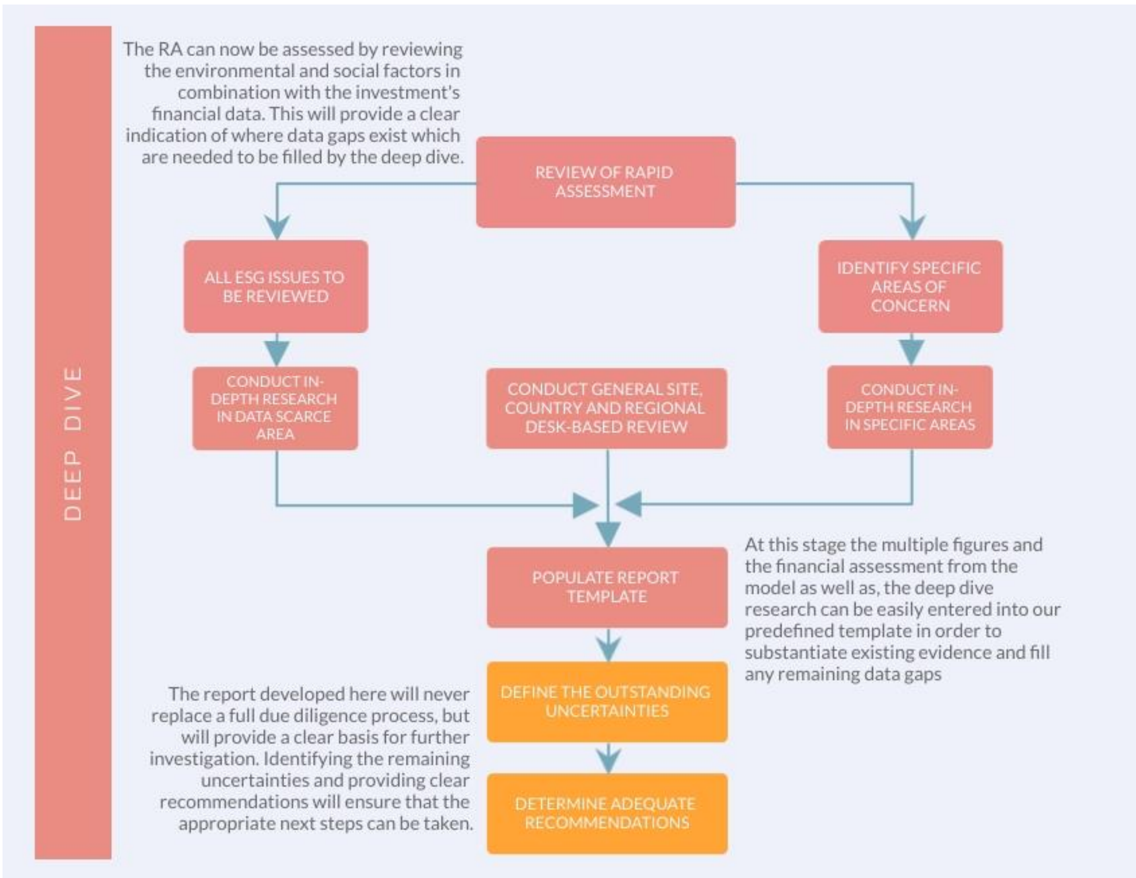
Riverscope combines a rapid quantitative geospatial assessment with a qualitative, desk-based Deep Dive into critical issues (see image below). This combination of approaches delivers a comprehensive, data-driven assessment that allows for a fair comparison across hydropower sites and projects.



Riverscope provides a robust means of assessing and linking commercial, social and environmental risk based on a statistical research process (see the full methodology here). It allows investors and other project backers like governments to see how the financial performance of dams is affected by their social and environmental risks. In doing so it shows that dams with lower social and environmental impact are less exposed to material risk.



This quantitative assessment of the bottom line is complemented by Deep Dive analyses of social and environmental factors. This Deep Dive draws on TMP's experience of desk-based due diligence and Environmental, Social and Governance (ESG) risk assessment for a wide range of clients over the last decade. We also understand that some important issues are, at a fundamental level, hard to quantify effectively. The Deep Dive therefore adds both focus and texture to Riverscope, helping to pull apart generic problems for large-scale dams and issues that are specific to the hydropower investment.



Riverscope provides a framework with which hydropower can be compared with alternatives on the basis of price, social benefit and environmental footprint. It therefore recognizes that combating energy poverty rapidly is an imperative. This is particularly valuable when trying to determine the least-impact alternative to hydropower, such as utility-scale solar which has a significantly lower social impact and can be implemented far more rapidly.

Rapid Assessment

The Rapid Assessment is based on a methodology developed and tested over several years with leading NGOs, research institutions, companies and investors for a system called Landscope, which was funded by the UK government.[1] It has at least three important attributes:

1. An assessment can be completed in a matter of hours. With further automation, this could be reduced to around a minute. Quick assessments can be justified at an early stage in the decision-making process, before too much has been committed.

2. Assessments link social, environmental and commercial risks. Integrated assessments can also be used to identify lower risk sites and alternatives that are more suitable for development.

3. It is a quantitative and statistically-based assessment that provides a repeatable process. Complex factors can be interpreted as comparable indicators. These indicators are derived from a robust statistical process and so are demonstrably correlated with risk.

This last attribute is particularly important: the Rapid Assessment is based exclusively on analysis of 281 dams. TMP created a geospatial profile for each of these dams that was composed of over 300 ESG reliable indicators. When we say "reliable" we mean that they come from reputable sources (e.g. NASA, the UN, Oxford University) and have been vetted by our team over a multiyear process.

This process has involved ground truthing datasets involving, among others, nine development finance institutions in an intensive 18-month process. All told, over a hundred businesses and NGOs have been involved in data testing. Data was compared with projects that testers were already very familiar with and where a field visit had been conducted recently or was being planned. These field visits allowed us to compare data outputs with recent ground level realities. It also allows us to test the basic efficacy of the approach: the outputs both confirmed field visit priorities and identified new issues that had not been on the radar of consultants. In all, this testing process led to the exclusion of hundreds of datasets to leave us with a robust framework.

For Riverscope, we compared the geospatial profiles of 91 dams that are known to have significant ESG problems with the 190 dams that have not experienced reported problems.[2] By comparing these two sets of cases, we have been able to identify 17 social and environmental indicators that show statistically significant correlations with the dams that are known to have problems (see table overleaf and the full list of sources here). Riverscope, therefore, scores any area of interest based on its correlation with areas that have known problems.

[1] https://landscope.info/

[2] Some of the dams in our control group may have experienced problems that have not been reported

All scores have been presented on a scale from 0-100, with higher values representing higher risk. Any score below 45 (the value of our control group) is not similar to a place where we have seen problems in the past. As you will see in the table overleaf, these indicators relate to a diverse range of social and environmental conditions, including factors like poverty/deprivation, population density, conflict, water management, biodiversity and land use management.

List of statistically significant indicators for Environmental and Social issues. Indicator weightings[3] *Dam = 3; River = 2; District =1.*

Indicator	Indicator Description	Dam	River	Distr.
Environmental				
Minimum Percentage Water Scarcity Over the Year (Blue Water Scarcity Database)	WaterStat is the world's most comprehensive water footprint database. The minimum percentage water scarcity indicator is a unique dataset showing blue water scarcity in the world on a monthly basis at high spatial resolution. Blue water, or liquid water, can be compared with green water, in soil moisture and similar. We found that greater scarcity equated with greater risk.			
Species Richness that are Critical, Endangered, Vulnerable (IUCN Red List Species Database)	The IUCN Red List is a critical indicator of the health of the world's biodiversity. The species richness provides an indication of the number of species potentially occurring in a given location. We found that places with high species richness equated with higher risk.			
Global Sediment Flux (Modeled Global Suspended Sediment Flux)	The WBMsed model is a spatially and temporally explicit (pixel scale and daily) global sediment flux model. The indicator uses the modeled values to understand the global flow of sediments within the rivers which reflects the amount of nutrients and minerals that flow downstream to support the growth of life. Our assessment found that greater disruption of sediment flows makes dams more risky.			
Inter-Annual Variability (Aqueduct Global Maps)	Aqueduct's global water risk mapping tool helps companies, investors, governments, and other users understand where and how water risks and opportunities are emerging worldwide. The indicator measures the average between-year variability of available water supply, including both renewable surface and groundwater supplies. We found that higher variability was correlated with higher risk.			
Upstream Drainage Area (Global Drainage Basin Database)	The GDBD is a database made up of six GIS data collections (drainage basin boundary data, river network data, discharge gauging station data, natural lake data, dam lake data, and flow direction data) that store a wide range of information on			

[3] The weightings here are averaged for the specific area. For indicator specific weightings see the Statistical Model in the full methodology at http://riverscope.org/wp-content/uploads/2021/08/Riverscope-Rating-System-Methodology.pdf.

	natural and social sciences. Upstream drainage area provides an indication of the drainage basin into a particular river. The larger the area, the higher the risk.			
Protected Areas (World Database on Protected Areas)	This indicator is part of the most comprehensive global database on terrestrial and marine protected areas. It shows the proportion of the analyzed area covered by a protected area designation (such as national parks or conservation zones), as a percentage of the analyzed area. The higher the proportion of the impact zone that is covered by protected areas, the greater the risk for the dam.			
Percentage Cropland (SEA CCI)	The CCI-LC project delivers consistent global LC maps at 300 m spatial resolution on an annual basis from 1992 to 2015. This indicator draws on the area that is considered as cropland within the dataset. Counter-intuitively, we found that lower percentages of cropland correlated with higher risk, indicating risk in remote areas.			
Drought Severity (WRI)	The indicator considers the average length of droughts times the dryness of the droughts from 1901 to 2008 to develop a drought severity score in a specific area. The more problematic drought, the higher the risk for the dam.			
Social				
Percentage of People Who Are Poor and Deprived in Living Standards: Improved Sanitation (Multidimensional Poverty Index)	A person is considered to have access to improved sanitation if the household has some type of flush toilet or latrine, or ventilated improved pit or composting toilet, provided they are not shared. We found that higher levels of deprivation were associated with higher levels of risk.			
Percentage of People Who Are Poor and Deprived in Education: Schooling (Multidimensional Poverty Index)	The MPI uses two indicators that complement each other: one looks at completed years of schooling of household members, the other at whether children are attending school. The better the school attendance, the lower the risk.			
Percentage of People Who Are Poor and Deprived in Living Standards: Drinking water	A person has access to clean drinking water if the water source is any of the following types: piped water, public tap, borehole or pump, protected well, protected			

(Multidimensional Poverty Index)	spring or rainwater, and it is within a distance of 30 minutes' walk (roundtrip). Higher levels of deprivation associate with higher risk.			
Multidimensional Poverty Index of the country (Multidimensional Poverty Index)	Measures acute poverty: the proportion of people who experience multiple deprivations and the intensity of such deprivations. Higher levels of deprivation, again, associate with higher risk.			
Population Vulnerable to Poverty (Multidimensional Poverty Index)	Identifies a threshold score for the MPI indicators to suggest people are vulnerable to becoming impoverished and should conditions not improve, will fall into severe poverty. Higher levels of vulnerability correlate with higher risk for the dam.			
Population density (GPWv4)	The Gridded Population of the World, Version 4 (GPWv4) consists of estimates of human population (number of persons per pixel), consistent with national censuses and population registers, for the years 2000, 2005, 2010, 2015, and 2020. To our surprise, lower population densities correlate with higher risks.			
Night Lights (Earth City Lights Database)	This image of Earth's city lights was created with data from the Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS). The brightest areas of the Earth are the most urbanized, but not necessarily the most populated. To our surprise, lower light levels correlate with higher risks, suggesting that remote areas are problematic.			
Conflict Number of Explosions & Remote Violence (ACLED)	ACLED collects real-time data on the locations, dates, actors, fatalities, and types of all reported political violence and protest events across the world. This indicator considers all Explosions and incidences of Remote Violence. The more frequent the incident of violence, the higher the risk.			
Conflict Events including Protests, Strategic Developments and Riots (ACLED)	ACLED collects real-time data on the locations, dates, actors, fatalities, and types of all reported political violence and protest events across the world. This indicator considers Protests, Strategic Developments and Riot events. The more frequent the incident of violence, the higher the risk.			

Geospatial analysis: Defining impact areas

The impacts of dams are both wide-reaching and quite uneven. We therefore needed an approach for defining the impact area of a dam that could be universally applied to capture these characteristics using the quite granular data available from our indicators. This was quite challenging because, in practice, every dam is different. We have used three generic and distinct levels of analysis: Dam, River and District. Each level of analysis is supported and can be extended via the Deep Dive process to enable tailoring.

The area immediately around the dam generally experiences the most intense impact: we have used a 20km circular buffer around the location of the dam itself for indicators with the highest weighting. This area contains the inundation area in addition to the potential social and environmental impacts, such as deforestation and conflict which are often associated with the construction of large dams. We do, however, recognize that in many cases the inundation area is larger than the buffer area, which we pick up where relevant in Deep Dive analysis.

Many impacts are felt more extensively but often less intensively downstream. Our second tier of indicators therefore looks 100km downstream of a main tributary or to the coast, taking a buffer 10km either side of the river. This captures the effects that a dam can have on downstream river-dependent populations whose livelihoods, particularly those involved in farming and fishing, revolve around seasonal flow regimes. [4] This level of analysis considers things like impacts on silt flows, fisheries, water quality and various social factors.

Finally, dams have wide reaching impacts that need to be seen in cumulative terms with other dams developed in the area. Our final tier therefore analyses indicators at the district level, or Administrative Level 2 (GADM L2).[5] Together, these three tiers help us to roughly quantify the risk of incidence in spatial terms i.e. they can give us a score that shows which places are most likely to suffer from problems.

In identifying these places and developing the Rapid Assessment process, we demonstrated a few interesting facts about hydropower:

- Dams which suffer from ESG problems can experience long delays. On average, our test group experienced delays longer than 10 years.
- Dams which suffer from ESG problems are more likely to be in remote, biodiverse areas with little prior land use change which increases the prevalence/likelihood of conflict.
- Dams which are most at risk are situated in areas with a low population density and with recorded high levels of poverty.

[4] https://www.tandfonline.com/doi/abs/10.1080/00167223.2016.1258318?src=recsys&journalCode=rdgs20

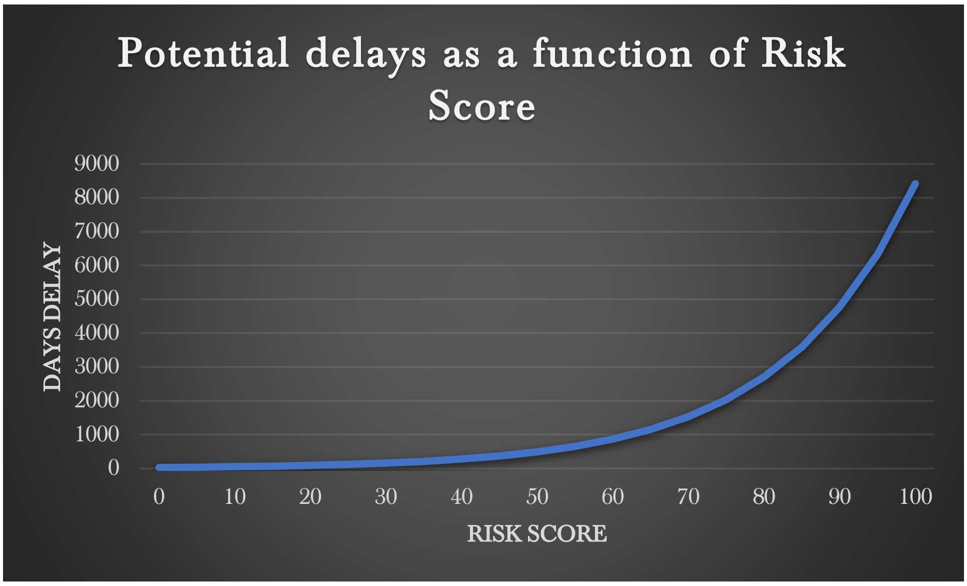
[5] https://gadm.org/

Other studies of hydropower reinforce the idea that this is a sector prone to significant delays and slippage.[6] The fact that these problems are connected to ESG risks is well evidenced by our analysis. But perhaps the most interesting finding relates to the conditions that create risk for hydropower projects. Many projects are developed in remote locations with low population densities, despite the challenges this creates for logistics and transmission. Our investigation shows that this approach is serving to increase risk, rather than mitigate it.

Financial modelling

The Rapid Assessment score plugs into a Discounted Cashflow Model (DCM) to provide an assessment of a project's Net Present Value (NPV) and the likely Levelized Cost of Electricity (LCOE) that it will deliver. These metrics are widely used and can be easily compared with alternatives like solar, wind or geothermal.

The financial model is based on research conducted by TMP and the ODI over the last four years.[7] This research looks at the way that ESG risks create financial impacts via delay and slippage. For Riverscope, we have looked at 91 dams that have had problems to establish delays that could be attributable to social or environmental factors. Using these delay values, we have created a distribution of possible delays (see graphic below).



The Rapid Assessment score shows where the dam being analyzed sits on this distribution i.e. how long the delays would be if a dam planned for this location experienced problems. For example, according to the graph above, we should expect a dam with a score of 40 to be delayed by an average of 278 days (<1 year) and a dam with a score of 80 to be delayed by 2703 days (7 years). In other words, we use a statistically robust method to determine ESG risk then show how receipt of revenues could be delayed by social and environmental problems to change the financial proposition of a project.

[6] https://www.sciencedirect.com/science/article/abs/pii/S0301421513010926
[7] https://www.odi.org/publications/11283-assessing-costs-tenure-risks-agribusinesses

Our approach assumes that a risk score of 0 equates to no delays. The distribution of the number of delays then follows an exponential distribution. That is, the longer the project is delayed, the number of days increases exponentially. The same result was derived in the paper by Callegari et. al. which analyses the distribution of delays in various energy projects[8].

These delays are then combined with different assumptions around overruns in spending and different discount rates (or different costs of capital) to produce assessments of a project's LCOE, NPV and other widely used and understood financial metrics. These efforts rely in part on previous research on hydropower which, for example, shows typical capital expenditures are 33% higher than initially budgeted[9].

Overall, this approach to financial modelling recognizes that there is considerable uncertainty around the way that dams will be developed by providing projections for a range of scenarios. Naturally, we recognize that the Rapid Assessment process as a whole has weaknesses. For this reason, the Rapid Assessment is followed by a qualitative Deep Dive.

Deep Dive

We know that numbers do not always tell the whole story and that statistics can lie. The Deep Dive is designed to address these weaknesses by complementing the quantitative nature of the Rapid Assessment with a qualitative investigation. The Deep Dive therefore helps us to engage with complex and/or recent issues that are not well or fully captured by currently available geospatial data.

For example, the impact of COVID-19 on large projects like hydropower developments will be significant and potentially enduring, however, the disease's effects are also uneven and hard to predict. Similarly, issues like corruption and political governance are inherently hard to assess through a data-driven approach. Finally, issues like biodiversity are not well represented by numbers alone. It makes sense to investigate these issues with the benefit of experience, intuition and expertise.

In the case of Riverscope, the Deep Dive issues include but are not limited to:

- Commercial risks: Delays and slippage; Levelised cost of electricity; Offtake arrangements
- Environmental risks: Biodiversity; Hazards; Climate
- Social risks: Food Security; Human Displacement; Political Risks; Cultural Risks

Of course, the Deep Dive cannot get to the bottom of everything and so we list "Remaining Uncertainties" in the final report. The Deep Dive process relies on reviews of key project documents, like the Environmental and Social Impact Assessments; relevant research reports; academic journals, along with the limited use of media and NGO reports. In general, we treat this latter category with caution because of occasional reliability issues.

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[8] https://www.sciencedirect.com/science/article/abs/pii/S0301421517308042

[9] https://www.tandfonline.com/doi/full/10.1080/07900627.2019.1568232