A New Landscape Approach to Assess Alternative Hydropower Opportunities

Andrew Cauldwell – ERM Technical Director

FOR

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SPECIAL SYMPOSIUM

MAINSTREAMING THE MITIGATION HIERARCHY IN IMPACT ASSESSMENT

15 November 2017

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Background to the Study

- Govt of Congo requested the IFC to advise on the Sounda Gorge Hydropower Dam.
- Prefeasibility studies conducted for five full supply levels (FSL).
- Alignment to the PS6 will be challenging on the higher FSLs, but may be possible for the smaller options until 70m FSL, emphasis on PS6.

Sounda Gorge HPP Full Supply Option	Reservoir Extent (km^2)	Avg. Annual Power Generation (GWh)	Installed Capacity (MW)	Investment Cost (USD x 10^6)	LCOE-1 HPP only (USD/kWh)
116.5 m a.s.l.	1 432	6 631	1 193	2 670	0.036
95 m a.s.l.	546	5 100	929	2 053	0.041
80 m a.s.l.	196	4 032	749	1 608	0.048
70 m a.s.l.	**59**	**3 394**	**628**	**1 446**	**0.055**
60 m a.s.l.	**17**	**2 761**	**504**	**1 313**	**0.064**

Why the Need for Alternatives

- All the Performance Standards would apply to the Development of Sounda, with higher challenges for the following:
  - PS 4 - Community Health, Safety and Security
  - PS 5 - Land Acquisition & Involuntary Resettlement
  - PS 6 - Biodiversity Conservation & Sustainable Mgmt. of Living Natural Resources
  - PS 7 - Indigenous Peoples
  - PS 8 - Cultural Heritage
- The PS 6 requires if a critical habitat is affected, the client will not implement a project unless:

“***no other viable alternatives exist in non-critical habitats***”

- The other Performance Standards also promote avoidance of impacts and the principles of the mitigation hierarchy.

Location of Sounda Gorge Hydropower Dam

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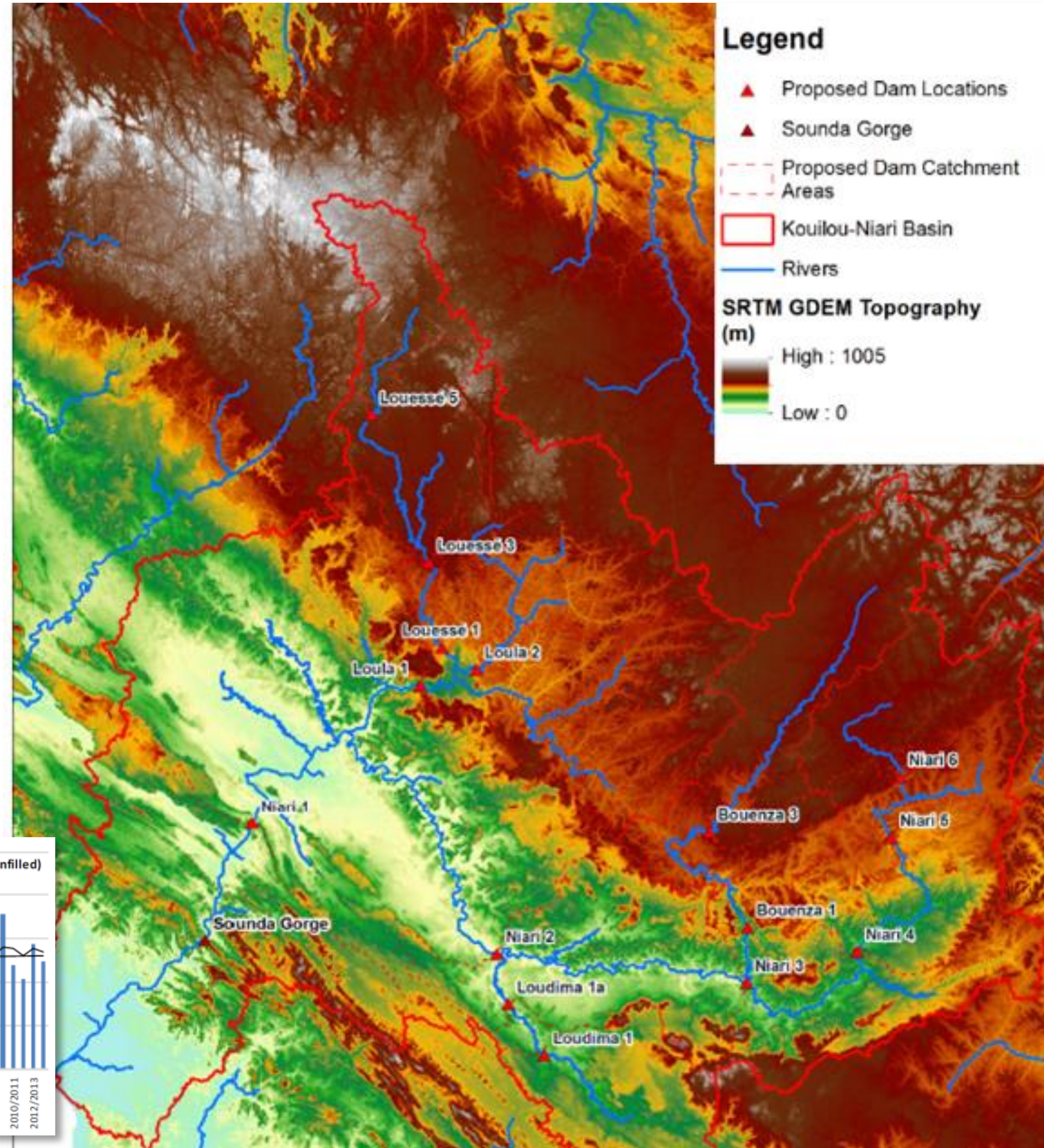
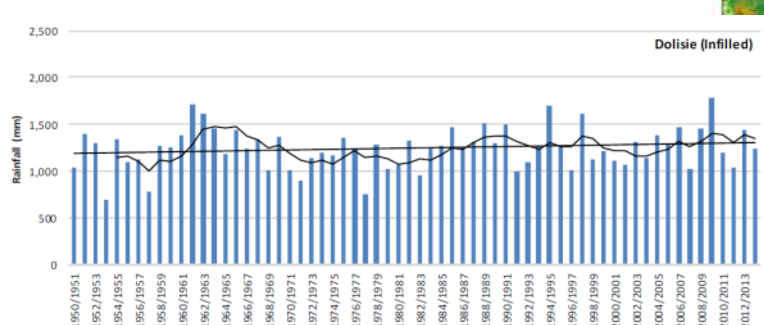
Team Composition

International Finance Corporation (Global)	
Markus Scheuermaier	Coordination
Delphine Arri	Lead Environmental and Social Specialist for Sounda
Dzenan Malovic	Engineering Specialist
Amalia Fernandez Bilbao	Biodiversity Specialist
Mott McDonald (Singapore)	
Philipe Cazalis De Fondouce	Director and Engineering Lead
Mauricio Carvalho Ortega	Hydropower Engineering Design
Tom Beskeen	Hydrologist
Kai En Lam	Hydropower Mechanical Engineer
The Nature Conservancy (TNC) Washington, Maine, Gabon	
Colin Apse	Freshwater and Conservation Specialist, Lead
Matthew McGrath	Hydropower Specialist Coordination
Emily Chapin	GIS Analysis
Erik Martin	GIS Analysis
The University of Manchester, UK	
Julien Harou	Director and Trade-off Modelling, Lead
Anthony Hurford	Trade-off analysis modelling
Specialist Inputs	
Marine Robillard (Anthropolinks, Paris)	Indigenous People Specialist
Michiel Jonker (Ecotone, Johannesburg)	Aquatic Ecology Specialist
ERM, Johannesburg	
Mike Everett	Partner
Andrew Cauldwell	Project Management & Biodiversity

Identified Potential Sites

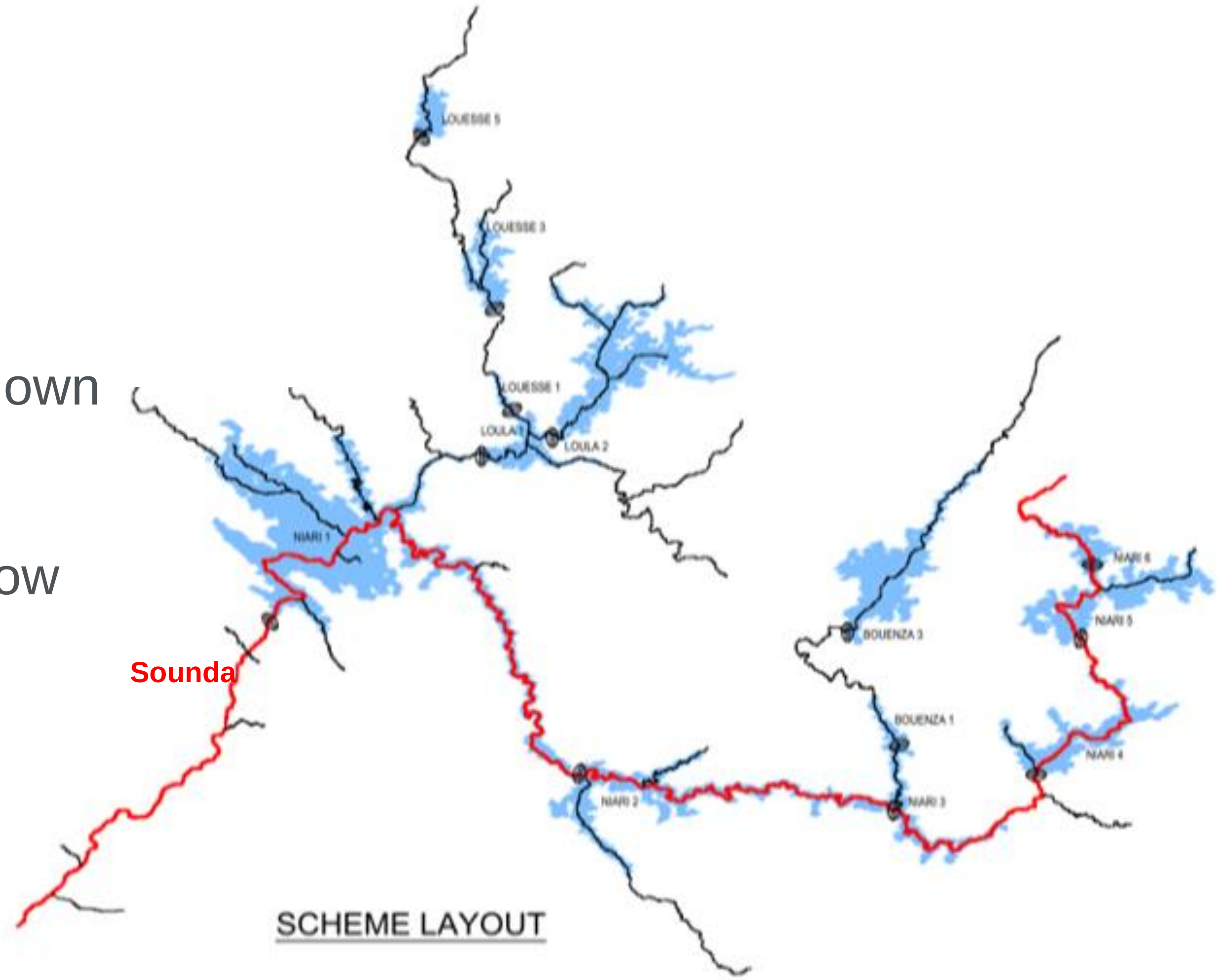
- Developed digital terrain model using SRTM data.
- Hydrology was modelled from data available online.
- Used the results to identify potential hydropower sites.





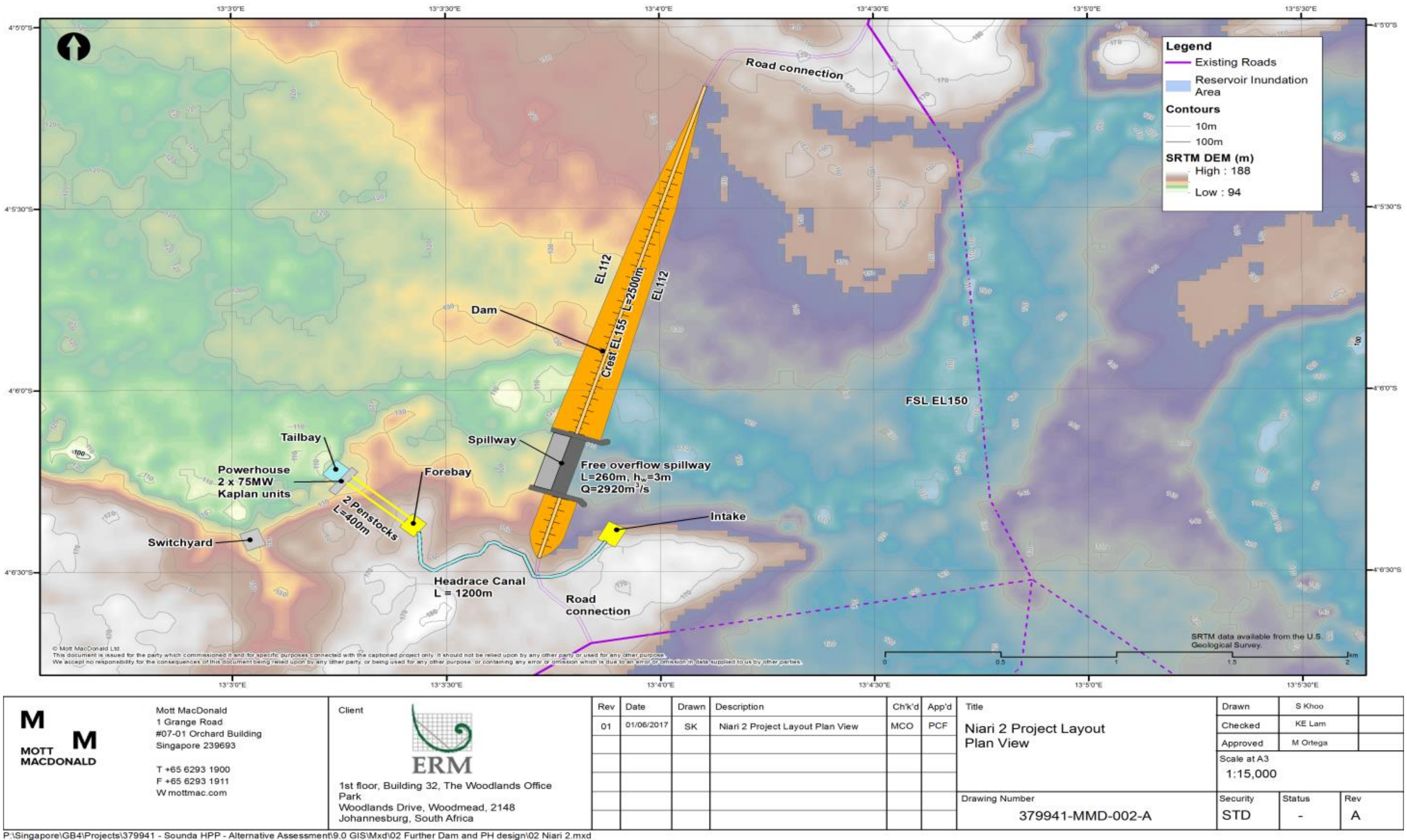
Identified Potential Sites

- Initially identified 17 hydropower sites.
- Some overlaps with existing sites.
- Sites were trimmed down to eight sites by excluding overlaps, severe impacts and low performance.
- Retained a cascade along the Niari River (red).



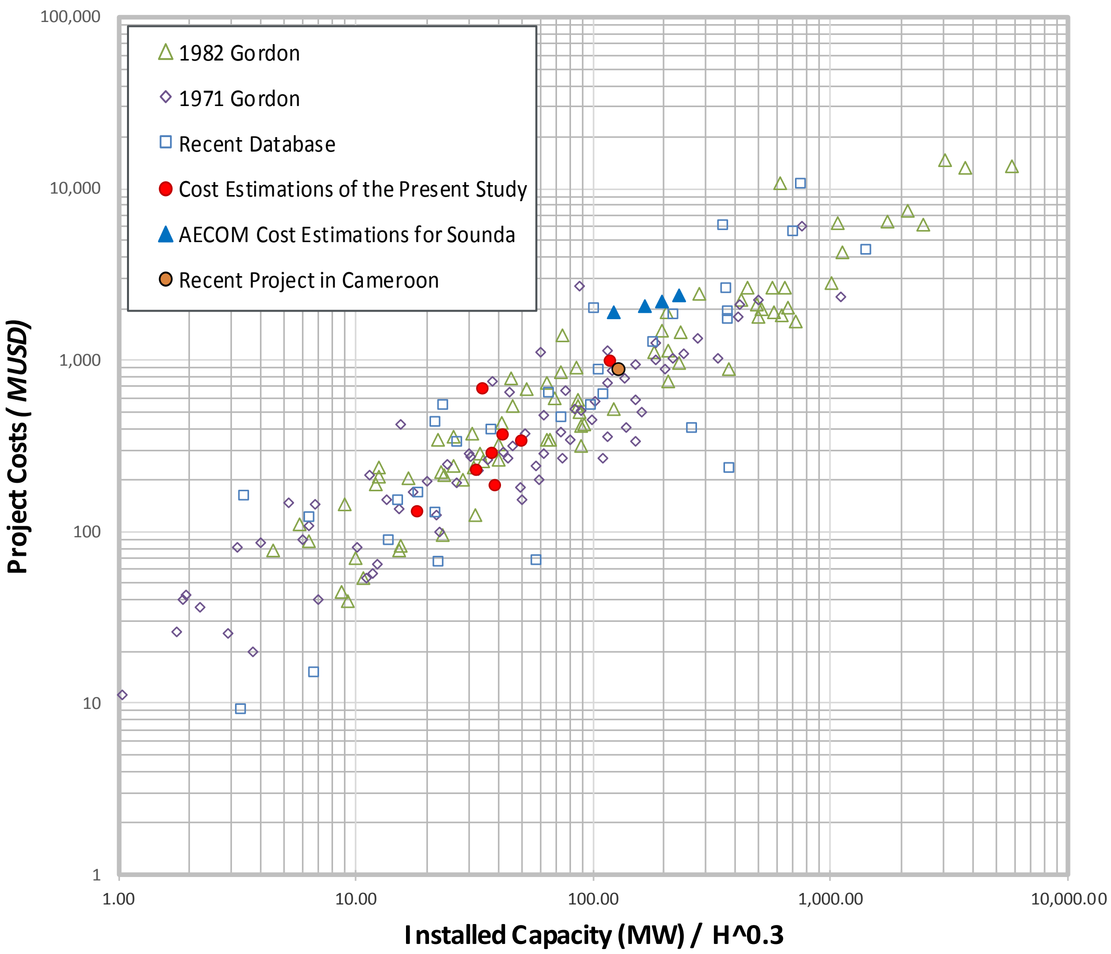
Developed Engineering Designs

- Developed designs for each Hydropower Scheme and the need for ancillary infrastructure, such as roads and transmission lines



Estimated Construction Costs

- Calculated power generation potential.
- Calculated costs of construction to be comparable to Sounda.
- Calculated Levelised Cost of Energy (LCOE) for each site.

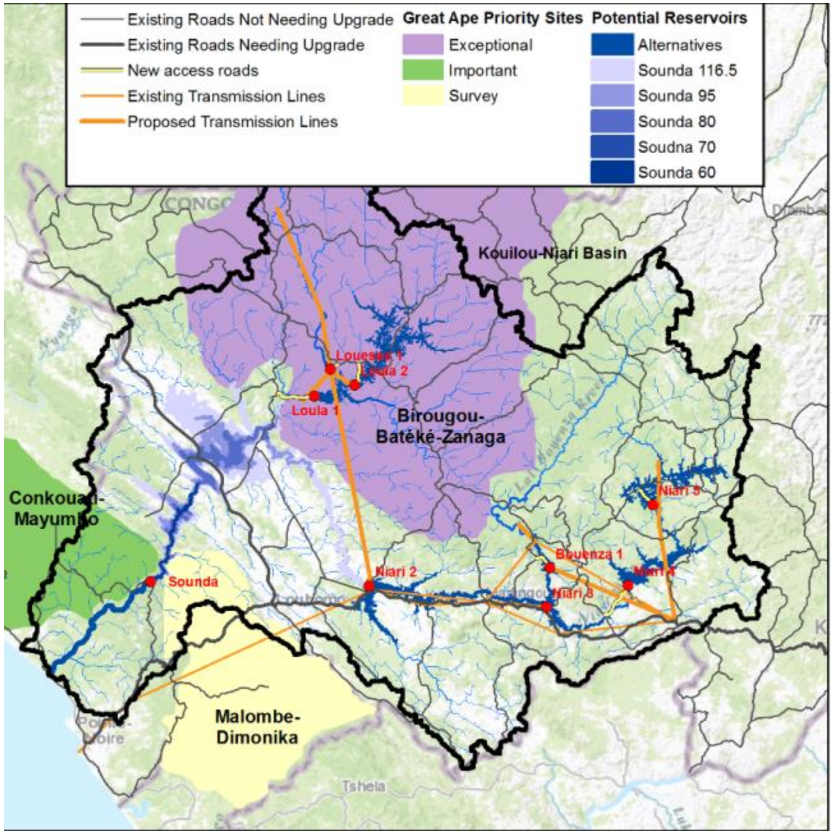


Engineering Results

HPP Scheme	Reservoir Area (km²)	Type of HPP Scheme	Average Annual Energy (GWh)	Installed Capacity (MW)	Total Project Cost (USD x 10^3)
Bouenza-1	23.5	Power House at toe	832.95	135	689 346
Niari-2	218.3	Diversion (1.2 km)	916.36	150	417 972
Niari-3	56.1	Power House at toe	563.61	90	239 751
Niari-4	122.0	Power House at toe	338.90	55	141 559
Niari-5	118.1	Diversion (10.5 km)	1 255.10	207	388 101
Loula-1	42.5	Diversion (0.5 km)	3 249.97	537	1 160 670
Loula-2	111.4	Diversion (1.4 km)	1 045.41	171	350 980
Louéssé-1	1.5	Run of River & Diversion (0.9 km)	999.62	169	206 033

Hydropower by Design Framework

- HbD is a broad landscape approach for the assessment of the benefits and impacts from Hydropower by TNC.
- Assessed 27 quantifiable metrics covering Engineering, Financial, Biodiversity and Social parameters.
- University of Manchester further modelled power generation over cascades of sites.
- Prioritised 10 metrics for a trade-off analysis of portfolios of site to compare against Sounda.



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Ten Metrics Used in the Trade-off Analysis

Group	Metric	Type of Metric	Direction of Optimization
Engineering and Financial	Average Annual Generation	Dynamic	Maximize
	Firm Power	Dynamic	Maximize
	Investment Cost	Fixed	Minimize
	Infrastructure Loss	Fixed	Minimize
Social	Indigenous People Displaced	Fixed	Minimize
Biodiversity	Low Flow Alteration	Dynamic	Minimize
	Migratory Fish Habitat Loss	Cumulative	Maximize
	Infrastructure in Priority Great Ape Landscapes	Cumulative	Minimize

Additional Metrics that were Analysed

Engineering and Financial

- Reservoir live storage
- Reservoir total storage
- Firm Generation
- Road access (km)
- Grid access (km)
- Installed capacity (MW)
- Unit costs (USD/kW)
- Levelized Cost of Electricity (LCOE)

Social

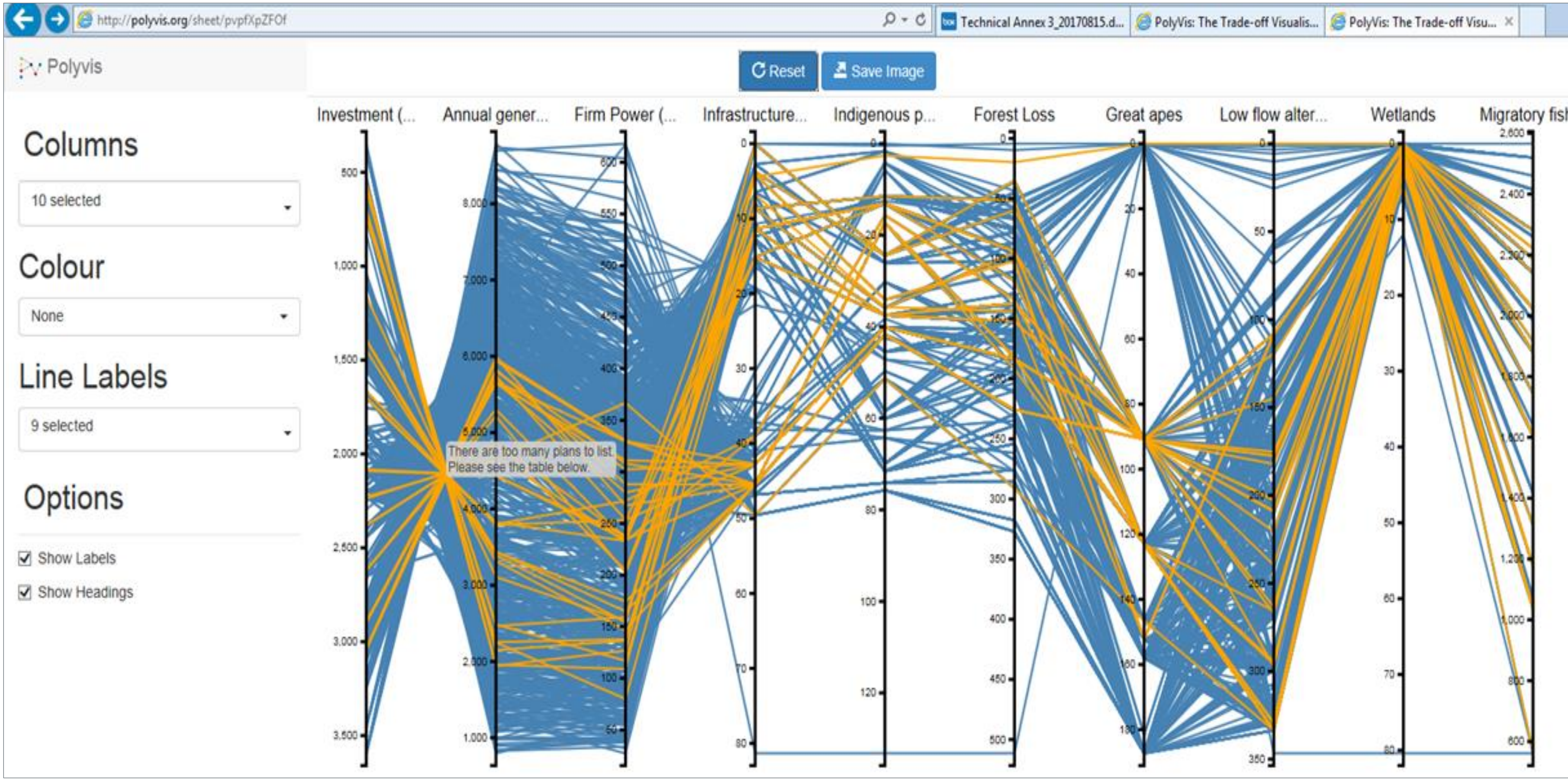
- Inundated settlement localities
- Extent of inundated villages
- Inundated indigenous people localities
- Extent of cropland inundated
- Extent of pastureland inundated

Biodiversity

- Protected areas inundated
- Intact forests inundated loss
- Number of disconnected tributaries
- Imperilled (threatened) fish species

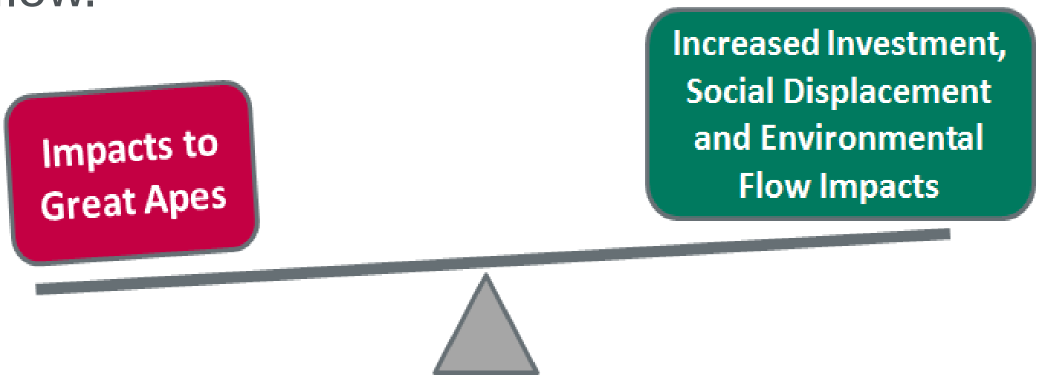
Results of the Trade-off Analysis

- Polyvis tool by University of Manchester was used to compile and filter data onto a parallel plot to assess the various trade-offs



Results

- Selecting the best portfolio was a trade-off of Great Ape impacts against a 44% Increase in Cost, Social Displacement and Environmental flow.



- In Summary:
- We matched the cost and power output of Sounda 70 m FSL, but with a trade-off of Great Ape Tier 1 critical habitat against impacts to migratory fish and shrimps.
- The Great Ape impacts are unlikely to be mitigated, whereas alignment to PS6 is more likely to be achieved with Sounda for options 70m FSL and below.

Achievements of this Project

- Produced a thorough example of a multi-disciplinary alternatives analysis of complex hydropower opportunities.
- Satisfied the requirement of Performance Standard 6 to investigate alternatives.
- Provided a Conclusive Result.
- Produced a simple easily understood result from a very large and technically complex data set.
  - Demonstrated effectiveness of the Hydropower by Design Framework to analyse this complex data.

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