WWF

REPORT

2017

THE TRUE COST OF POWER

THE FACTS AND RISKS OF BUILDING STIEGLER'S GORGE HYDROPOWER DAM IN SELOUS GAME RESERVE, TANZANIA

ACKNOWLEDGEMENTS

The two reports were independently written by Barnaby Dye and Joerg Hartmann.

WWF

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Cover image: Fishing boat in Kilindoni harbour, Mafia Island, Tanzania. The proposed Stiegler's Gorge dam will have far reaching risks that extend over 180 kilometres to the rich fisheries off the Rufiji Delta and Mafia Island. Up to 200,000 people's livelihoods could be impacted by the hydropower project.

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SELOUS GAME RESERVE AND STIEGLER'S GORGE

SELOUS GAME RESERVE IS A WORLD HERITAGE SITE. SINCE 2014 IT HAS BEEN INSCRIBED ON THE LIST OF WORLD HERITAGE IN DANGER PRIMARILY BECAUSE OF ELEPHANT POACHING

However the World Heritage committee has raised additional concerns about industrial pressures on the Game Reserve. These include extractive concessions and a hydropower dam at Stiegler's Gorge.

WWF is working alongside partners to help deliver the Tanzanian government's plan to prevent poaching in the Selous Game Reserve. This involves delivering an Emergency Action Plan to help Selous Game Reserve be taken off the List of World Heritage in Danger. In addition to this WWF wants to develop sustainable use of resources and livelihoods for the communities next to it and those affected by the Stiegler's Gorge for example downstream of the Selous on the Rufiji River.

Earlier this year WWF commissioned consultants to carry out two pieces of research into Stiegler's Gorge. One looked at the background to it, including the stakeholders involved. The other piece of research was a rapid assessment of the potential impacts from constructing the hydropower dam in Stiegler's Gorge. This publication includes these two reports.

These research pieces do highlight a number of issues that are relevant to the dam and need to be considered. The current discussion around the dam is centers on the footprint of the dam and reservoir but has not examined the wider impacts downstream on people's livelihoods and the economic consequences of building this dam as opposed to the alternatives contained in the Tanzania Power System Master Plan (2016 update).

By releasing these reports WWF hopes it will encourage debate about the full effects of building a dam in Stiegler's Gorge. As set out in Tanzanian law a Strategic Environmental Assessment will have to be carried out and this should be supported by a range of studies to ensure the Tanzanian government can make a wise choice about its power generation for its people and economy.

It should be noted that recent discussions between the Tanzanian and Ethiopian governments have not mentioned the Brazilian company Odebrecht although at the time of writing the reports in this publication the company was strongly associated with the dam. WWF is not aware of the status of Odebrecht or Ethiopia in relation to building the dam.

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STIEGLER'S GORGE IS LOCATED IN THE SELOUS GAME RESERVE, A WORLD HERITAGE SITE

WWF POSITION

Selous Game Reserve is a driver for sustainable development giving long-term benefits to Tanzania and its people Tanzania needs increased energy to help drive its development. The government has set out its 2025 energy vision in the Tanzania Power System Master Plan (2016 update).

WWF opposes developments in Protected Areas that negatively impact on their ecological core values – in the case of World Heritage Sites this is called its Outstanding Universal Value. The IUCN mission in February 2017 identified that the construction of Stielger's Gorge would impact on the ecology of the Selous and livelihoods beyond the protected area's borders.

WWF commissioned research into the Stiegler's Gorge project that strongly indicates significant impacts both inside and outside of the Selous, on local economies, people's livelihoods as well as environment. As the project continues to be promoted WWF is calling for rigorous, transparent research to be carried out as part of a Strategic Environmental Assessment for the Selous catchment area as required under Tanzanian law. The results should be made public to allow a discussion and evaluation of the true benefits to Tanzania.

SUMMARY OF REPORT FINDINGS

A hydropower dam at Stiegler's Gorge has been presented as an energy generating option for Tanzania since the 1960s. Up to recently while the dam has been highlighted as a silver bullet to solve Tanzania's energy needs there has been no serious drive to build it in the short term. However, it is now listed in the Tanzania Power System Master Plan (2016 update), to be built by 2035. In June 2017 President Magufuli stated publically that he wanted Stiegler's Gorge to be built to provide power to help Tanzania develop.

Stiegler's Gorge is located in the Selous Game Reserve, a World Heritage Site. An estimate for the land inundated by the resulting reservoir behind the dam is 1,200km^2 meaning it would be the largest reservoir in East Africa.

There are wider impacts beyond the physical inundation of 1,200km^2 of land and the construction of the dam that must be considered. There will be increased erosion downstream, the potential to dry out lakes that are important for wildlife tourism, reduced fertility of farmland downstream and the retreating of the Rufiji Delta and potential collapse of the fish, prawn and shrimp fisheries found there. This could negatively impact over 200,000 livelihoods as mentioned below.

IT IS IN CONFLICT WITH THE PRINCIPLES OF WORLD HERITAGE CONVENTIONS THAT TANZANIA HAS SIGNED

Selous Game Reserve is already listed under "properties in danger by the World Heritage Convention due to increased poaching. Government of Tanzania has prepared an Emergency Action Plan and Desired State of Conservation Report that shows how Tanzania will address poaching issues and lift the Selous Game Reserve out of that list. The planned dam construction will not reduce pressure on Selous Game Reserve.

Since 2009 the proposals for a hydropower dam there has been raised as a concern by IUCN and UNESCO's World Heritage Committee (WHC). Over the last decade calls for it to be abandoned have increased. This culminated in Istanbul in 2016 with the WHC

decision stating its 'utmost concern about the ongoing Stiegler's Gorge dam project despite a high likelihood of serious and irreversible damage to the Outstanding Universal Value (OUV) of the property'. In addition the WHC adopted a position against large dams and reservoirs within its properties.

Following their mission to the Selous in February 2017 the IUCN is now calling the project 'fatally flawed' because of the impact on the ecology of the Selous and the impact on livelihoods beyond the protected area's borders. They have called on Tanzania to 'permanently abandon' it. This wording is included in the 2017 WHC draft decision:

> Considering the high likelihood of serious and irreversible damage to the Outstanding Universal Value (OUV) of the property resulting from the Stiegler's Gorge Hydropower project, and noting the inclusion of the project in the updated 2016 national Power System Master Plan, strongly urges the State Party to permanently abandon the project;

IT WOULD HAVE A DETRIMENTAL IMPACT ON THE DOWNSTREAM RUFIJI RIVER TO THE INDIAN OCEAN

Current discussions on the impacts of the Stiegler's Gorge project have focused on the direct physical impacts from the dam and reservoir. However, there could be far reaching negative impacts on the landscape downstream both in the Selous Game Reserve and beyond. The dam would trap most of the estimate 16.6 million tons of sediment (per year). Reduced sediment and nutrients carried by the river would lead to increased erosion downstream, the isolation of lakes, less flooding of farmland leading to less soil fertility, the shrinking of the Rufiji delta and of the largest mangrove forest in East Africa, and reduced fish, shrimp and prawn fisheries in the delta and off shore.

IT WOULD RISK NEGATIVELY IMPACTING ON OVER 200,000 PEOPLE'S LIVELIHOODS

The impact on Tanzania's largest river would affect many ecosystem services it provides. It would affect tourism in Selous downstream in some of the most abundant wildlife areas in the game reserve. These impacts could also negatively affect a further 200,000 peoples' livelihoods, such as farmers and fishermen, as far away as the Rufiji delta and the islands beyond.

IT WOULD JEOPARDISE THE INTEGRITY OF THREE GLOBALLY SIGNIFICANT PROTECTED AREAS

Not only would the Selous World Heritage Site be impacted by the creation of a 1,200km2 reservoir within it but also the Rufiji-Mafia-Kilwa Marine Ramsar Site would be threatened. The dam would trap sediment and organic matter usually transported in the river to the coast. The loss of sediment and organic matter transported to the Ramsar site would result in the delta shrinking and loss of food for the marine species found there. It is unprecedented to risk losing the integrity of not one, but two globally significant protected areas to a hydropower project. In addition the dam would probably stop the seasonal migration of fish up the Rufiji River to the Kilombero Valley Floodplain Ramsar site upstream. This would impact on the ecology of the Ramsar site.

THE IMPACT ON TANZANIA'S LARGEST RIVER WOULD AFFECT MANY ECOSYSTEM SERVICES IT PROVIDES

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THERE ARE ALTERNATIVE LESS IMPACTFUL PROJECTS THAT CAN GENERATE A SIMILAR QUANTITY OF POWER

STIEGLER'S GORGE PROJECT IS CONTRARY TO THE CURRENT PLANNED INVESTMENT IN TOURISM AND TOURIST INFRASTRUCTURE IN SELOUS GAME RESERVE

The World Bank is proposing a $100 million infrastructure loan for southern Tanzania to boost tourism and the German government recently signed a contract for an €18 million 5-year conservation plan for Selous. Tanzania has invested in new airplanes to boost tourism and President Magufuli has spearheaded a drive to protect Tanzania's elephants for tourism. Yet much of this is at risk if Stiegler's Gorge is developed.

NEED TO TAKE NOTE OF THE EFFECT OF CLIMATE CHANGE

Climate change is predicted to impact southern Tanzania by increasing rainfall variability that will reduce the security of hydropower schemes in this region. The documents put forward on the project have not taken this into consideration.

THERE ARE ALTERNATIVE POWER SOURCES TO SUPPORT TANZANIA'S INDUSTRIAL AND ECONOMIC GROWTH

There are alternative less impactful projects that can generate a similar quantity of power. These projects are highlighted in the Tanzania Power System Master Plan (2016 update). The 2017 IUCN mission report that representatives from the Ministry of Energy and Minerals confirmed Stiegler's Gorge dam project is 'only considered as a back-up option should all other options fail'.

IT SHOULD NOT BE CONSIDERED IN ISOLATION

The focus so far has been on the site and the direct impacts of building a dam, the dam itself and the resulting reservoir. However there has been little discussion about the cumulative impacts of other projects (other hydropower dams, irrigation schemes, mining, and oil & gas exploitation) on the flows and water quality of the rivers, the potential impacts on this project and the users downstream of Selous. Other options need to be considered in detail as well.

WAY FORWARD

ACCORDING TO SECTIONS 104 AND 105 OF TANZANIA'S ENVIRONMENTAL MANAGEMENT ACT OF 2004, BEFORE A DAM IS BUILT A STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA) NEEDS TO BE CARRIED OUT

An SEA is a tool that will inform decision makers about the impact of the choices they are about to make and how to avoid such impacts. An SEA will also help to engage the stakeholders and inform decisions by bringing all the relevant stakeholders together.

WWF has previously identified five key principles that are constant across well managed World Heritage sites. These can help decision makers achieve an appropriate and equitable balance between conservation, sustainability and development. A SEA will help move the process along sustainability principles, namely ensuring the principles are applied to Selous to help its decision makers and maximize sustainable development. These principles are:

- Valuation that is socially conscious
- Investment decisions that focus on long-term values
- Governance that is representative of all beneficiaries
- Policymaking that is evidence-based and transparent
- Regulations that are enforced and followed

The size and impact of Stiegler's Gorge project on Tanzania's people's livelihoods and its environment makes it vitally important that these principles are adhered to.

Alongside the required SEA, other important studies that will help to inform on the true cost and benefit to Tanzania of building a hydropower dam at Stiegler's Gorge include the following:

- Economic valuation of fisheries and agriculture downstream of the dam
- Hydrological Surveys to determine flows and environmental flows needed downstream
- Hydropower Sustainability Assessment
- Economic valuation of the Selous Game Reserve as tourist destination

THE STIEGLER'S GORGE HYDROPOWER DAM PROJECT

A BRIEFING REPORT FOR WWF

Barnaby Dye

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The Stiegler's Gorge Hydropower Dam Project

A Briefing Report for WWF

Barnaby Dye, University of Oxford

The Stiegler's Gorge project is being planned in the Selous Game Reserve. This paper provides background and analysis of the actors and risks involved in the project, aiming to help WWF develop an informed opinion on the project. This report is the result of an analysis of the literature available and draws on extensive research carried out by the lead author, Barnaby Dye[1]. It was based on Joerg Hartmann (2012)'s Stiegler's Gorge Briefing for WWF who also advised on this document.

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[1] As an environmental impact assessment has not been conducted, there is only poor quality data available on the hydrology and sediments of the Rufiji River. Literature existing includes initial Environmental Impact Assessments as well as other scientific paper and policy reports on the Selous Reserve and the delta area. Primary research drawn on here consists of over 100 interviews conducted with officials in Tanzania and Brazil during 2015-2016.

Acronyms

EIA/ESIA	Environmental Impact Assessment/Environmental and Social Impact Assessment
ExIm	Export Import Bank
Gwh	Gigawatt Hours
ha.	Hectares
km	Kilometres
MEM	Ministry of Energy and Minerals
MW	Megawatts
MoU	Memorandum of Understanding
OUV	Outstanding Universal Value
PSMP	Power System Master Plan
Tch	Trillion Cubic Feet (of gas)

Location

The Rufiji is Tanzania's most important river. The basin covers a fifth of the country, providing an estimated mean annual runoff (MAR) of 20.58 billion m3 (or an average flow of 652 m3/s) at the potential dam site of the Stiegler's Gorge, some 230 km upstream of the river mouth. Above the gorge, the three main tributaries meet and form the headwaters of the lower Rufiji basin; below the gorge are the floodplain

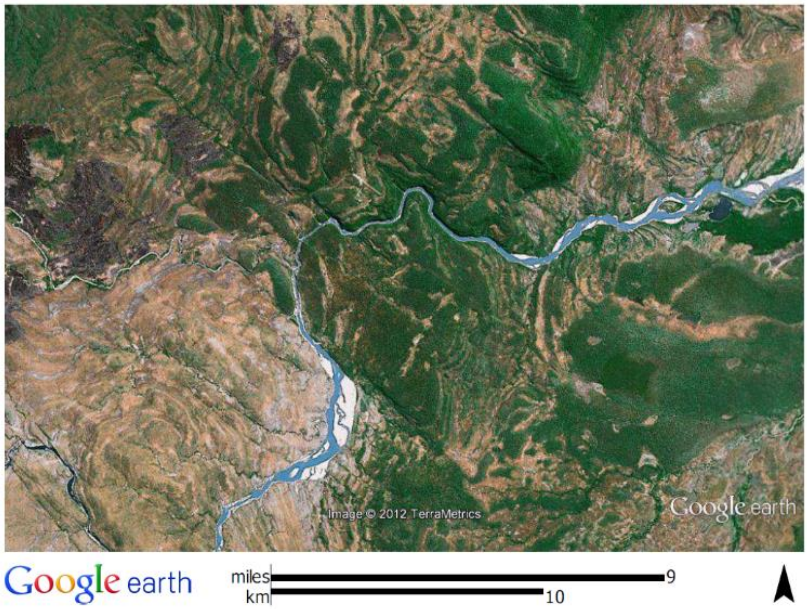

Figure 1 Satellite View of the Dam Site in the Selous Reserve

and delta of the lower Rufiji. The gorge itself is about 8 km long and 100 m deep. The gorge sits in the middle of the Selous Game Reserve, one of the World's largest protected and most significant wildlife areas, being roughly the size of Switzerland. The reserve was made a UNESCO World Heritage Site for the outstanding universal value of its unique ecology in 1982.

Figure 2 Example of a CFRF dam. Source http://www.allcons.de

The Project

A hydropower dam is currently being proposed for the Stiegler's Gorge. The proposal involves a 126m, concrete-faced rock fill dam across the gorge. Additionally, four saddle dams totalling 14km will be built upstream to confine the reservoir[2]. It is planned to be an independent power project, that is, one owned and built by private companies then in contract with power purchasers.

Project History

Dating back to colonial expeditions, the dam seems to have been first conceived by an engineer called Stigler who planned to build a bridge and dam over the gorge. He was killed in 1907 by an elephant, reputedly falling into the gorge then named after him[3]. Regular studies of the river and development projects along it continued from the 1900s-1960s[4]. In 1961, after a decade of discussion and studies, the Food and Agriculture Organisation published a report specifically considering the project, but primarily for irrigation[5]. This was eventually taken on by the Norwegian Development Agency (NORAD) who carried out studies during the 1970s primarily focused on the dam as a hydropower project[6]. These included relatively detailed feasibility, design and environmental studies. Nyerere was a particular proponent of the project, seeing it as a potential foundation for the country's development and industrialisation[7]. This has given the project a high status for many in the ruling CCM party as a project with nation-building potential. Officials and later Nyerere, visited the Tennessee Valley Corporation, an institution premised on top-down

Figure 3 Stiegler's Gorge

[2] Odebrecht, 2013a
[3] Baldus, 2009
[4] Havenick, 1993; Hoag and Öhman, 2008
[5] Havenick, 1993; Hamerlynck et.al., 2010
[6] Havenick, 1993; Hoag and Öhman, 2008
[7] Havenick, 1993

development through dam building. This inspired the Rufiji Basin Development Agency (Rubada) in 1975 which had the Stiegler's Gorge dam at the heart of its mission[8]. However, once the studies were completed in the 1980s, the project was not taken on by any financier, with the World Bank in particular rejecting the project. Therefore, the Stiegler's Gorge Dam was effectively shelved from the mid-1980s[9].

Resurrection of the Project

President Kikwete's 2006 arrival in government, combined with changes in Tanesco and an up-turn in the economy, cemented a policy shift in the energy sector. The effect of decades of economic stagnation, deteriorating power plants and transmission grids had been made painfully clear by a prolonged, drought-induced power crisis in 2004-2006[10]. In this context, the government resolved to invest in new generation. The turned to projects included many that were longstanding, and the Stiegler's Gorge was the most ambitious. In order to push the project forward, a new Chairman and Director General were appointed to Rubada. They increased the income of the agency and extended its activity and media presence, with interviews and press statements anticipating the dam's arrival and amplifying its benefits[11]. Their efforts to secure an international partner for the project were supported by the wider government.

Figure 4 Stiegler's Gorge

A series of companies expressed interest in developing the project including IDF (Infrastructure Development Finance Ltd) of South Africa and Energen of Canada in 2006-2008[12]. This was reputedly followed by Sinohydro who made a bid to develop the project[13]. However, the active diplomacy of Brazil, through the country's ambassador appointed in 2009 and crucial Presidential visit in 2010, brought more concrete steps with a more experienced, international company. The project was discussed at a high level, between Ministry representatives and senior company executives. Odebrecht was the company most interested in the Stiegler's Gorge, being Brazil's largest construction company internationally and because it has experience across Africa, including in the similarly-sized


Figure 5 Signing of the MoU between Rubada and Odebrecht

[8] Havenick, 1993
[9] Havenick, 1993; Hamerlynck et.al., 2010
[10] Kapika and Eberhard, 2013
[11] Interviews 2015-16
[12] https://www.africaintelligence.com/AEM/electricity/2008/06/04/energem-in-power-play,43269914-ART; http://ae-africa.com/read_article.php?NID=180
[13] Interviews 2015-16

(2069.5MW) Lauca dam in Angola. Trust between the countries and relevant organisations were secured with further high-level visits by Tanzanian ministers to Brazil between 2010-2013, including by President Kikwete. This resulted in an MoU being signed in July of 2012. These events are relevant in indicating the high-level commitment to the project and the way in which diplomacy and Tanzania's energy crises were crucial drivers pushing the project forward.

Current Status: The dam as a medium-term threat

Figure 6 Construction Works Plan Taken from Odebrecht, 2013b

The project has experienced stagnation since the MoU between Rubada and Odebrecht was signed. This can be related to a number of factors. A crucial element of this was the replacement of the Minister for Energy in 2012. Whereas Mr Ngeleja, the previous minister, had been supportive of the project and allocated funding for its future planning[14], his replacement and the current incumbent Minister Muhongo, takes a more hydro-sceptic position. He has primarily invested in new gas generation[15].

This move echoes wider unease among officials in Tanesco and the MEM about hydropower. Tanzania's major incidences of power shortage and crippling load shedding have occurred with droughts, notably in 2004-6, 2011 and 2015. The main power plants on the Ruaha River (an upstream tributary of the Rufiji) have dried up in these droughts, stopping energy production there. Thus, scepticism has grown among government decision-makers about building more hydropower plants generally, when they have proven vulnerable to strong seasonal fluctuation and drought. The desire to increase the reliability of the power through decreasing reliance on hydropower is reflected in official policy such as the Power System Master Plans (2009, 2012), the five-year plan of 2010/11-2015/16 and in the National Energy Policy of 2015[16]. This does not mean that the Stiegler's Gorge project has been abandoned: It is listed as a long-term energy project in the PSMPs (2009, 2012) and as a longer-term plan in the Big Results Now (2012) scheme. However, it does evidence a degree of debate about hydropower that make it difficult for dam projects to gain funding and approval. Large discoveries of natural gas in Tanzania over the last decade have provided an increasingly plentiful alternative source of power which has been attractive to Tanzanian policy-makers for its reliability, shorter build-time and planning and as it can be added in small stages. The government's commitment to hydropower more widely and the Stiegler's Gorge in particular is thus long-term and appears ambiguous because of an un-centralised and unclear planning process in the energy sector that has not definitively ruled it in or out. Its long held esteem in the ruling CCM party

[14] http://allafrica.com/stories/201205040224.html
[15] Interviews in Tanzania and http://uk.reuters.com/article/tanzania-hydropower-drought-idUKL8N14I10J20151229
[16] Specific examples including FYDP I, Page 4; World Bank, 2013 Program outline Page 46; World Bank, 2014 Program outline Page 63

as a Nyerere project is counterbalanced by recent experiences of hydropower failure and questions over finance feasibility.

Despite a lack of funding, planning for the project has proceeded through Odebrecht's efforts and Rubada's commitment to implementation. These included site visits and a review of the existing documentation[17]. A situation analysis report and initial environmental impact assessment have been produced as a pre-feasibility-type report[18]. The company has also opened up an office in the country. The MoU for the dam was renewed in 2016 with Rubada[19].

The difficulties faced by the Stiegler's Gorge project are in many ways typical of the energy sector: the government fails to prioritise clearly, is severely financially handicapped, has a complex and fragmented approval process and has a strongly personalised system of decision-making which is therefore unpredictable and changeable. Tanesco is hampered by debts and frequently misses payments, giving its agreements little value. Corruption is rife with notable deals including the IPTL and Escrow scandals around emergency power projects[20]. Very few projects involving the private sector and private-ownership such as is proposed for Stiegler's, are therefore completed.

Thus, whilst Odebrecht appear committed to a plan for approaching the financing of the Stiegler's Gorge and represent a competent experienced developer, the dam will face a number of difficulties in its advancement to implementation. This situation has been made worse by the 'car wash' scandal in Brazil involving high-level state corruption. Some members of the company's senior management are in jail as a result of their involvement, including the family CEO Marcelo Odebrecht. Its international reputation has thus suffered, as has its support by the Brazilian state. This is partly because of the allegations against Brazil's development bank, the BNDES, which has consequently pulled back international financing[21]. Odebrecht, being a 70% internationalised company, can raise finance from elsewhere, including multilateral funding (AfDB, World Bank, EIIC) or national export credit agencies. Indeed, it appears that the process of building international financing has started to be considered. However, as detailed below, legal charges and reputational damage mean the company's future remains uncertain. These combined factors mean the project has somewhat stalled and faces a number of hurdles. It can therefore be considered a medium term threat to the Selous reserve, rather than an imminent one.

[17] Interviews 2015-16
[18] Odebrecht, 2013a; Arms on Environment, 2013
[19] Interviews 2015-16
[20] See Briefing Paper by Zitto Kabwe http://www.orcis.com/escrow/Makala_Zitto_HowPAPAcquiredIPTL.pdf
[21] See Dye, 2016

Analysis of Key Actors in Tanzania

RUBADA

The Rufiji River Basin Authority is the key agent legally charged with promoting the project by its founding 1975 act. Its mission is to implement development projects in the Rufiji basin, primarily involving dams. Its major relevance today remains in the preparation and implementation of these projects, and so it has a strong incentive to see implementation. The Independent Power Producer model adds further incentive as, as far as Rubada is concerned, it will become a member of the consortium owning the project, earning substantial revenue from the hydropower plant's operation. This is particularly pertinent given the marginal role of the organisation since the failure of the project in the 1980s. It has seen its importance, staff and funding fall, being moved from the President's Planning Office to the less important Ministry of Agriculture[22]. The organisation is therefore strongly committed to the project and as such, its official statements are almost entirely positive, rather than holistic about the socio-ecological risks at stake.

Figure 7 Rubada's Logo

Ministry of Mines and Energy

Despite not being the legal project promotors or developers the Ministry still remains central to the planning of the project. The top Minister decides over the relevant government budget for energy project preparation, as well as dictating overall energy sector planning including generation technology preferences. The Ministry also plays an important role in financial guarantees and in the granting of various required permissions[23]. As a ministry their actions suggest less interest in the protection of the Selous, pioneering Uranium mining in the reserve and continuing to hand-out mining concessions throughout the park[24].

Tanzania Electric Supply Company Limited (TANESCO)

The National Electricity company are the sole transmitters of power within Tanzania and will maintain a distribution monopoly for the foreseeable future[25]. They would therefore be a key partner in the Stiegler's project as the buyers of power for Tanzania and transmitter to power-purchasing country's or corporations. They also play an important technical role in the planning of the energy system. A Power Purchase Agreement (PPA) would be with Tanzania in the first instance although this may not be enough to make the project bankable due to the company's significant debt and payment history (eg. recent Symbian Case[26]).

Ministry of Water and River Basin Authorities (Rufiji River Basin Authority)

A 2009 Water Act instituted a new regime in Tanzania where water is proposed to be managed on a regional scale and in a more participatory manor by River Basin Water Authorities made up of

[22] Interviews 2015-16
[23] Interviews 2015-16
[24] UNESCO, 2014
[25] It is the author's opinion that the proposed Power Sector Reform roadmap will not be fully implemented in the medium term.
[26] Symbian and Tanesco have been in recent legal disputes over owed payments

government and Water User Association representatives. The Rufiji River Basin Authority is the relevant institution in this case and will be in charge of granting a water user permit and the terms contained within. Downstream water users in the delta will therefore theoretically get a say over the project, although it seems unlikely to go against a project of 'national interest' such as the Stiegler's Gorge.

Ministry for the Environment and National Environmental Management Council

As of the 2004 Act and subsequent government edicts, Environmental Impact Assessments are now mandatory in Tanzania. For a large project such as the Stiegler's Gorge, a substantive impact assessment is required, likely including a public hearing stage. Assessments are then submitted to the NEMC for assessment of the technical quality of the EIA. The NEMC then passes it on to the Minister of the Environment who grants or withholds permission. Whilst it is unlikely that the Minister would oppose such projects of apparent national interest, and there is no precedent for such an action being taken, the Ministers are normally quite powerful within the ruling CCM party. The incumbent is no exception being a Presidential candidate in the primaries and widely seen as a long-term presidential prospect[27]. Potential thus exists for them to act stridently.

Ministry of Natural Resources and Tourism and Wildlife Division/TAWA

This is the parent Ministry for the Selous's management and for liaising with UNESCO. It directs the Wildlife Division, newly reorganised into TAWA (Tanzanian Wildlife Authority) which is in charge of managing Tanzania's protected reserves (notably distinct from National Parks). The Selous has been the major cash earner for this Division, resulting in poor retention of park revenue and consequent insufficient resources to protect the reserve from poaching[28]. The Stiegler's Gorge offers an opportunity to increase revenue for the management of the park. However, this has recently increased anyway with the re-introduction of a German sponsored program of grant financing and technical support which is premised on the reserve retaining at least 50% of its revenue. The management issue with the Selous therefore appears not to be in the amount of money it creates, but rather the institutions managing it, their retention of revenue and local community context[29].

Odebrecht

Brazil's largest construction company is now predominantly internationalised, receiving 73% of its revenue internationally in 2015[30]. It operates in 40 countries with 70 nationalities in the company's 128,000 employees[31]. It has tended to operate with a long-term perspective, valuing the building of close relations with governments and in creating a positive corporate image. This includes adopting international standards of corporate social responsibility including through local training and development schemes, for which it has a good international reputation. Moreover, in line with this image and the need of the company to attract international finance, it follows protocols like the Equator Principals[32]. It has built 54GW of hydropower over the company's life-time, so therefore constitutes an experienced international partner capable of constructing a project with the scale of

[27] http://africanarguments.org/2015/02/18/can-january-makamba-be-the-next-president-of-tanzania-by-ben-taylor/
[28] Interviews 2015-16
[29] Interviews 2015-16; Baldus, 2009
[30] http://www.odebrecht.com/en/communication/releases/construtora-norberto-odebrechts-revenue-steady-reported-brl-331-billion-2014
[31] Interview with Odebrecht representative, September 2016.
[32] Odebrecht, 2013a

Stiegler's Gorge. Indeed, it is currently engaged in a similarly sized Lauca dam in Angola. Odebrecht also have experience of World Heritage Sites. They built a large highway infrastructure project in Panama City's heritage area, aiding its acceptance by UNESCO through active diplomatic support and the commissioning of impact studies[33]. This all suggests the company's suitability for the Stiegler's Gorge.

However, the 'car wash' scandal has caused a series of set-backs, as indicated above. 12 countries are reportedly pursing bribe cases against the firm[34] and it has already been forced to pay $3.5bn in fines to Brazilian, US and Swiss authorities. A number of market commentators question its future[35]. Although international reach limits damage and reputational loss, and there seems to be a focus on core engineering business and international projects, its credit rating has been reduced to CC by Fitch[36].

Odebrecht Stiegler's Gorge report suggests that to some degree, downstream impacts and risks to the World Heritage Status of the Selous, have been overlooked. The report doesn't, for instance, mention UNESCO's pronouncements that the dam is incompatible with the reserve's outstanding universal value[37]. However, Odebrecht's report (2013a) does also demonstrate a willingness to engage in positive socio-economic measures, from local procurement to employment and training of communities. It has also suggested supporting the Selous's finances through a specific electricity tariff levy[38].

Brazilian Government

Under the charismatic Lula de Silva, Brazil engaged in a dramatic expansion of international relations, no more so than in Africa. His leadership saw growing diplomatic efforts aimed at south-south ties. They were instituted through the opening of embassies and Ministerial and Presidential missions[39], including to Tanzania, garbed in grand rhetoric of solidarity. As part of this expansion, development cooperation was increased and companies encouraged to expand in operations. The Brazilian government therefore supported Odebrecht along with a number of other companies, identifying projects of interest, assisting with high-level access and by providing finance through the BNDES development bank. This program of support has changed through the Presidency of Dilma and recent political turmoil, underpinned by an ongoing and dramatic economic crisis, that has seen a change in government. The new administration is less inclined to foreign policy, particularly in Africa, and resultantly BNDES funding has been largely withdrawn. However, the Foreign Ministry is still engaged in support for Brazilian companies, especially through its embassies, with Tanzania being no exception[40].

[33] Interviews 2015-16 and http://apublica.org/2013/07/obra-da-odebrecht-panama-pode-colocar-em-risco-patrimonio-mundial-da-humanidade/
[34] http://www.reuters.com/article/us-brazil-corruption-odebrecht-idUSKBN15209G
[35] https://www.ft.com/content/8edf5b2c-c868-11e6-9043-7e34c07b46ef
https://www.ft.com/content/0ea31576-b831-11e6-ba85-95d1533d9a62
[36] https://www.bloomberg.com/news/articles/2017-01-17/odebrecht-said-to-outline-survival-plan-after-record-graft-fine
[37] As stated in UNESCO 2011, 35 COM 7B.6, onward
[38] Odebrecht, 2013b
[39] Stolte, 2013
[40] Dye, 2016

Hydrology and Reservoir Size[41]

The flow at the site shows a high variability, both seasonally and inter-annually:

- Average monthly flows range from about 250 m3/s in October to 2,200 m3/s in April.
- Annual flows range from 10.03 bcm to 58.21 bcm.
- The highest recorded flow has been variously given as 11,000 or 20,000 m3/s, the lowest as 70 m3/s. Downstream floods occur at flows above 2,500 m3/s (the "bankfull" capacity of the lower Rufiji).
- Through low-level outlets in the dam wall, a flood release capacity of 2500m^3s^{-1} is possible. Earlier 4000m^3s^{-1} capacity rejected around 1983 in earlier planning phase[42]
- [1] Duvail et.al.'s (2014) model indicates that even if a mitigating flood release was adopted, with this design, it would curtail the Rufiji's annual flood peak, and thus negatively alter downstream hydrology[43].

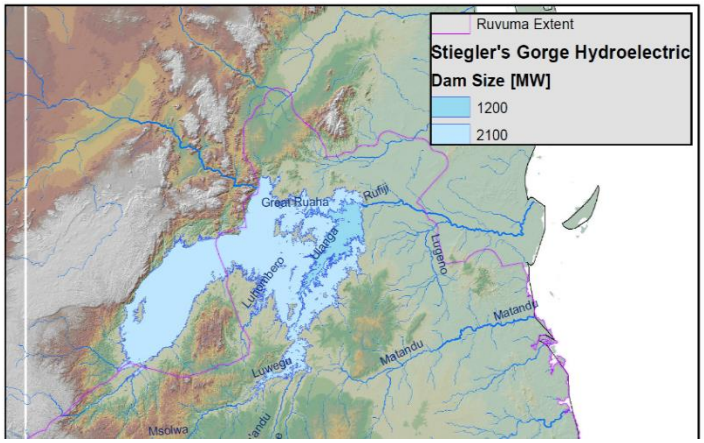

Figure 8 Picture of the potential reservoir from model. The diffrenece of this moel compared to that below demonstrates lack of clarity over its actual size and imapct.

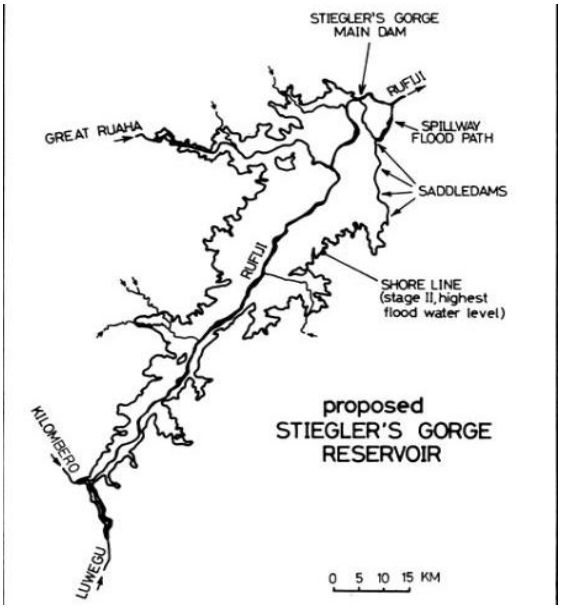

Figure 9 Depiction of the reservoir. Comparing with that above. Source Rubada

The storage capacity of a reservoir at Stiegler's Gorge depends on more detailed topographical work and a specific figure is not given in the preliminary reports. With the dam at 134m and the upstream topography indicated to be 22-34 bcm, the reservoir could store about 1 – 1.5 year's average runoff. A capacity of 34 bcm would create a reservoir with a surface area of 1,200 km2 (for comparison: Zanzibar Island 1,666 km2, Mtera Reservoir 660km). The average water residency, meaning the time taken for a unit of water to travel through the reservoir, would be 1.35 years. This predicted time for the Stiegler's reservoir is towards the high end of global norms of up to 2 years[44]. It compares favourably with other large African comparisons like Lake Kariba (5.7) or Lake Volta (4.3) but not with newer constructions like Sudan's Merowe (2 months). The longer this time is, the greater the disruption. This is particularly because it affects water macrobiotic life such as phytoplankton.

[41] Statistics based on report by Hartman, 2012
[42] Duvail et.al. 2014
[43] Duvail et.al. 2014
[44] Duvail et.al. 2014

Costs

Odebrecht's breakdown of costs in its initial scoping report puts the project at US$3.6 billion[45]. However, further feasibility studies might cause this to change as details emerge and cost overruns tend to be the rule rather than exception to such large infrastructure[46]. For comparison and illustration of cost risks, other recent regional project had much higher unit costs per megawatt (Bujagali in Uganda, with 800 million US$ for 250 MW, Rusumo on Rwanda/Tanzania border @ US$340m for 80MW or Nyabarongo at US$100 for 28MW[47]).

Tanzania could not finance the $3.6 billion project from its general budget (for comparison: total expenditure in fiscal year 2015/16 is US$ 12.2 billion) and the current plans for the project follow an Independent Power Producer model where a consortium invests and builds the project, generating profit through selling power. Odebrecht has a nascent plan for this involving financial markets, multilateral institutions and national ExIm banks. Odebrecht's report (2013a) mentions climate finance initiatives, particularly the World Bank run Carbon Finance Initiative, although it is doubtful whether the Stiegler's project would accepted for such finance. Another potential model that of the Brazil's Belo Monte dam that involved private investors and companies from Canada, China and Korea who have good financing options from their respective governments.

Context of the Stiegler's Gorge in the Energy Sector: Contributions and Appropriateness

The central rationale for the project, and its key source of financial sustainability, has always been in electricity production. The current plan of Odebrecht is to construct a 2096MW generation capacity with 6000GW/h firm energy per year. According to the National Energy policy of 2015, Tanzania had an installed generation capacity of 1,483 MW, although more recent additions of gas supply and the Kinyerezi I plant have reputedly pushed with to nearer 1750MW[48] including emergency power plants due to expire. Annual electricity consumption in 2014 stood at 4,175 GWh. The Stiegler's Gorge would thus more than double current total generation capacity and by itself, supply more energy than Tanzania currently consumes. This could be justified if the predictions of the government's Power System Master Plan are taken at face value. In the PSMP 2009 these showed, 6,091MW and over 35,000 Gwh in peak demand and generation by 2033. The plan therefore, (according to PSMPs 2009 and 2012) is to raise generation to 9,610MW over this time.

The Stiegler's Gorge is argued to be the least cost option for Tanzania in terms of the investment required for average kilowatt hour generated ($/kWh). Hydropower is also argued to be a reliable, known technology that is renewable and the longest-lasting type of power plant

[45] Odebrecht 2013a
[46] Ansar et.al., 2014
[47] Dye, 2016
[48] http://www.tanzaniainvest.com/energy/tanzania-extends-power-generation-capacity-to-1754-mw-thanks-to-natural-gas

Rationale for the Dam: 1 Ending Power Cuts

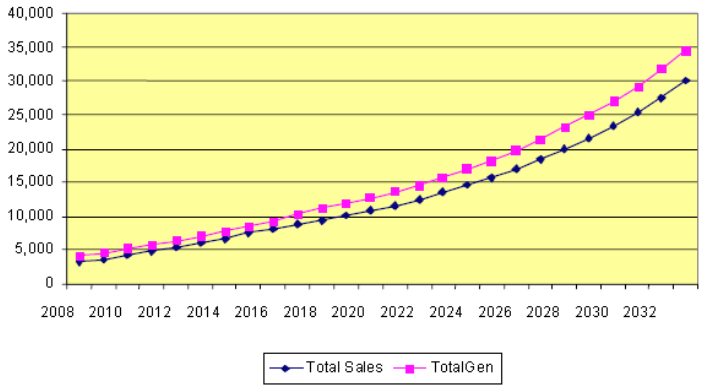

Figure 10 Source: Units in GWh SNC-Lavallin, PSMP (2009)

- Stiegler's Gorge has been seen as a 'silver bullet' solution to this power crisis primarily owing to the size of MW it could contribute.
- However, there are some doubts about the potential for such a project to effectively solve Tanzania's power issues relating to the seasonality of hydropower:
    - With insufficient data, it is uncertain how much the Stiegler's Gorge output would vary with the strongly seasonal Rufiji river.
    - The Stiegler's Gorges' reservoir is large compared to its river. However, it may still be vulnerable to drying up or having to spill water. The firm power, the power that can be more relied upon, should therefore be taken into account.
    - There are queries about whether a single seasonally affected plant should be responsible for such a large proportion of the country's generation.
    - Smaller reservoirs, such as Mtera Dam, have often dried up in drought years (although operational factors are also to blame) and consistently varied in output.
    - Power crisis in Tanzania occur in the dry season as they are caused by variability of electricity generation as well as an insufficient amount of total power being produced. Seasonality of the water cycle has thus negatively impacted the energy system.
    - Seasonal uncertain has been largely unaddressed in the planning of this dam so far: the plans stress the need to reduce seasonality with a large dam and storage capacity, but does not identify the extent of seasonality in power output or commit to details of reservoir operation.
    - As the dam will be privately owned, gaining money through selling electricity, the incentive for reservoir management will be to maximise power revenue, unless other uses like flood control are written into the licence.
    - Maximum electricity output might compromise mitigation efforts such as annual flood replication, and additional benefits like irrigation.

Climate Change is another significant factor, affecting water availability for hydropower:

- The last few decades have seen a number of frequent droughts and growing variability in rainfall
- Long term global forecasts predict increasing rainfall for East Africa[49], but indicate extreme floods and droughts will also increase[50]. This suggests more droughts and seasonally extreme river flows are likely.

[49] Milly et.al., 2005
[50] Colins et.al., 2015

The Stiegler's Gorge will therefore add a large volume of megawatts which could end power crises in Tanzania. But questions over the reliability of its output and vulnerability to long-term climate change, remain.

Rationale for the Dam: 2 Economic Growth and Industrialisation

- In the present context, electrification and industrialisation have been the key economic themes under Magufuli's new government, represented in 2016/17-2020/21 Five Year Plan.
- The Stigler's Gorge can aid Tanzania's electrification through its provision of abundant power that is crucially cheap (predicted levelled cost to be 4.5 cents/kWh[51]) and therefore more affordable to the low-income, unconnected majority of citizens.
- Moreover, the volume of megawatts and low cost of the power make Stiegler's Gorge capable of supporting industrialisation.
- However, certain political economy approaches to development suggest that the mere provision of electricity will not be capable of producing such economic transformation from a primary resource-driven economy to one with a strong service and industrial sector. Wider political, infrastructural, institutional, educational and path-dependant factors are also constraining industrial and economic growth in Tanzania.

Financial risk of the project given energy sector context

Firstly, given the likely impacts outlined below and effect on a World Heritage site and RAMSAR site, financing a project of this scale is a considerable and unlikely task. Currently, the project is envisioned as using a private sector model which could be a serious risk for Tanzania. Bankable PPA contracts tend to require guarantees for the owner to be paid for the power they are making available, even when it is not being dispatched on the grid. PPA contracts in Tanzania have controversially been even more generous than this, paying regardless of power being made available[52]. Either way, this obligation to pay constitutes a financial risk for country's with excess unused power in PPA contracts. The risk of adding the quantity of megawatts involved in the Stiegler's Gorge should thus be considered. Even if it is built in the proposed 300-900MW stages, these constitute significant additions of a quarter to a half of the current grid capacity, with the total 2100MW expected to be absorbed in under a decade.

The extent to which demand in Tanzania can grow at this rate is doubtable. Consultants and officials interviewed in the energy sector tend to see the government's forecasts predicting the need for roughly 1,500MW to grow to 10,000MW by 2030, as over-optimistic. This has led to protracted debates over the publishing of forecast reports[53]. In addition, current thinking is to build this project after a medium-term program adding 1000s of megawatts of hydropower, coal, gas and renewables. One option to overcome inadequate demand in Tanzania is to sell regionally through the East and Southern African Power Pools. This may be possible because of existing and planned international connectors. However, the demand for such a project in this international market is also in doubt as all countries in the region, not least Ethiopia, Kenya, Uganda and Rwanda, are planning large power projects explicitly for export[54]. Furthermore, Zambia, is turning to the Kafue and Batoka gorge[55]. Chances for export are therefore possible but uncertain with the Power Pool Institutions and trading

[51] Odebrecht 2013a
[52] See the IPTL scandal
[53] The latest was supposed to be published in 2015 but has yet to be released for this reason
[54] SNC Lavilin, 2011
[55] http://eng.sinohydro.com/index.php?m=content&c=index&a=show&catid=21&id=605

rules (like the Eastern African Power Pool) not operationally established. Questions over the need and financial feasibility of the project should therefore be considered.

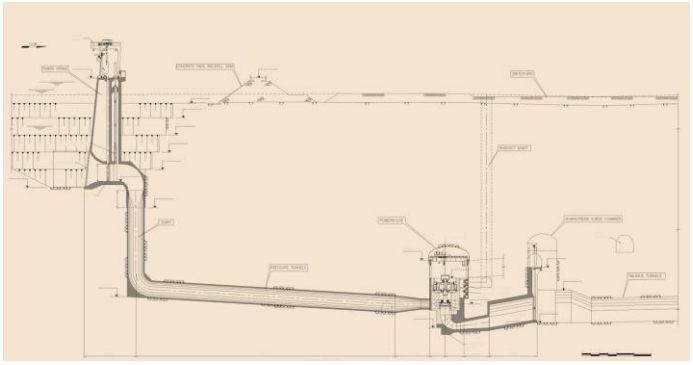

Figure 11 Engineering plan of the Stiegler's Gorge Dam and Power Plant. Source Odebrecht, 2013b

Overall, the energy sector context indicates the potential for the hydropower of Stiegler's Gorge but also risks concerned with the appropriateness of the project. On the one hand, cheap electricity is arguably necessary for Tanzania's development and meaningful electrification. However, there are questions over the reliability of hydropower, the sustainability of it given climate change, the rate of power demand growth and the consequent financial risk entailed by such a large addition of megawatts in a PPA.

Multi-purpose Possibilities: Flood Control, Irrigation and urban water supply

Flood control:

- Cited as a crucial advantage for the Stigler's Gorge by Rubada and central Government Ministries, with the dam reservoir regulating the flow
- Therefore, prevent destructive downstream flooding such as in 1968 or 2002 that caused household and crop destruction, resulting in river channel changes and food aid.
- However, no dam (not even one of this size) can guarantee complete protection from spilling and floods. For example, if the reservoir were 50% empty at the beginning of the rainy season (empty live storage of 11-17 bcm), in most years the floods could be contained but not in a high-flow year with flows of more than 30 or even 50 bcm. Another typical problem is then that people downstream become used to the temporary absence of floods and put their lives and property at risk, by living too close to the river[56].

The current project inception report by Odebrecht considers only the hydropower element but other hypothetical elements are mentioned by Rubada based on planning in the 1970s-80s.

Irrigation[57]:

- 80,000 ha proposed for the downstream floodplain
- Asserted possibility of 450,000 tons of paddy, 7,000 tons of maize, 3,000 tons of cotton, and vegetables.
- Large-scale irrigation downstream is probably not viable economically, for various reasons, including the inability to exclude flood damage by the Rufiji River. Duvail et.al. (2014) assert that irrigation infrastructure is pointless due to frequent destructive floods, even with the dam. It would be replacing river irrigation and fertilisation ecosystem services.

Water Supply:

- Potential to supply Dar es Salaam (190 km distance) and Morogoro (110 km) with drinking/sanitation water

[56] Taken from Hartmann, 2012
[57] Taken from Hartmann, 2012

- The associated investment costs are high. Alternative water sources are being developed at Kidunda Dam that also has minor impacts on the Selous Reserve

Overall, the potential for these multipurpose elements do not appear well founded. Moreover, reservoir management for these additional purposes would increase complexity and involve trade-offs between all the benefits, including electricity generation.

Figure 12 Stiegler's Gorge. Source Odebrecht 2013b

The Risks for the Ecology and Socio-Economy of the Rufiji River

Upstream Ecology

The Kilombero River, contributing roughly 60% of the Rufiji's flow, has a number of wetland environments used by migratory fish. Damming the gorge has the potential to disrupt the connectivity of habitats to the Rufiji delta and sea, reducing fish populations with consequences for the ecosystem and fishermen harvesting them[58].

Inundation

The main environmental risk focused on by Rubada and Odebrecht is the area that would be inundated. The Odebrecht report (2013a) states that it will only constitute 2.2% of the Selous Game Reserve and so will have a limited effect. The 1982 nomination by the IUCN of the Selous as a World Heritage Site echoes this point stating that the reserve is "so large that it can absorb all but the most severe pressures on its resources. There are plans to harness the flood waters of the Rufiji River, with a dam to be constructed at Stiegler's Gorge, but this would affect only a relatively small part of the Reserve and should not be a matter of serious concern unless the reservoir draws in large

Figure 13 Rough figure of the reservoir in the Reserve. Not based on detailed study. Source Odebrecht 2013b

[58] Arms on Environment 2013a

numbers of settlers." However, environmental expert opinion appears to have markedly changed. In contrast, 2011 UNESCO's World Heritage Committee, advised by IUCN, urged Tanzania's government to "abandon plans for the different development projects which are incompatible with the World Heritage Status of the property, in particular the Stiegler's Gorge dam". Similar statements have followed each year including the most recent 2016 conference that adopted a statement which "reiterates its utmost concern about … B) the ongoing Stiegler's Gorge dam project despite a high likelihood of serious and irreversible damage to the Outstanding Universal Value (OUV) of the property".

Proponents including those in government, Rubada and Odebrecht use the precedent of Uranium mining in the park to argue that the area for inundation should be excluded and compensated with new land taken from elsewhere[59]. Owing to the reservoir's central location, rather than the mine's bordering land, this is harder to plausibly conceive.

Use of the reservoir[60]

Long term average fish yield of 3,700 tons (with a peak yield of 12,000 or even 20,000 tons in the early years) has been predicted, which could be complemented by aquaculture. This compares to a total annual catch for Tanzania of about 350,000 tons, mostly from inland waters. The order of magnitude of these predictions appears credible, for example in comparison with fisheries on the Zambezi. Plans for fisheries have continued to be mentioned in Odebrecht's report and by Rubada officials. A fishery implies the creation of established populations around the reservoir, which itself would increase pressure on the Selous and risk its OUV. Water quality in the reservoir and downstream can be expected to be problematic in the early years, until a new balance is established. Changing the reservoir level for various uses of the dam has the risk of increasing erosion by exposing large banks. For this reason, and because of the presence of numerous established and wildlife rich lakes downstream, tourist use of the reservoir is unlikely.

Construction Activities: Pollution and Poaching

The Selous is difficult to access, and construction or upgrading of roads (probably 120 – 160 km from Chalinze,) or conceivably upgrading of the TAZARA railway would be required, as well as the construction of transmission lines, possibly in the same corridor. Impacts near the many dam sites (four saddle dams are envisioned) would include construction traffic, noise, dust and waste and the quarries and workers, negatively affecting OUV. Work-camps would need building for the estimated 1200 people necessary for construction, with Odebrecht officials noting that these could be quality, long-lasting living areas[61]. This fits with the company's camps in other projects and with their reputation for good working and training conditions. Positive effects could include improved transport for those living along the roads and for tourists. Negative impacts are likely to be increased pollution as well as in poaching. This is partly because the roads increase access for poachers, but also because poaching could increase with a new population living inside the current reserve. This likelihood is supported by the precedent of poaching increasing with Shell's oil exploration throughout the Selous that involved road construction[62] and the TAZARA railway line which cuts through the northern edge of the reserve's core area and was built in the 1970s. Poaching is a key threat to the park's OUV currently, so the risk of further wildlife loss is particularly significant.

[59] Interviews 2015-16
[60] Taken from Hartmann, 2012
[61] Odebrecht 2013a and 2013b
[62] Baldus, 2009

Figure 14 The Stiegler's Gorge. Source Author

Downstream: Flow and Sediment Change

More long-lasting risks of the Stiegler's Gorge, stem from those it might have downstream. The planned hydropower dam is designed in the present inception report to deliver base load electricity, designing out large fluctuations of river flow. The dam would also trap most of the sediment from the catchment behind the dam wall.

The sediment load of the river at Stiegler's Gorge is estimated, based on relatively poor data, at 16.6 million tons per year. This is not a large amount, partly explained by the fact that some sediment is already being trapped in upstream reservoirs and wetlands. This would make a small reduction in storage capacity over time but also have downstream effects, both to river morphology and because sediments deliver fertility.

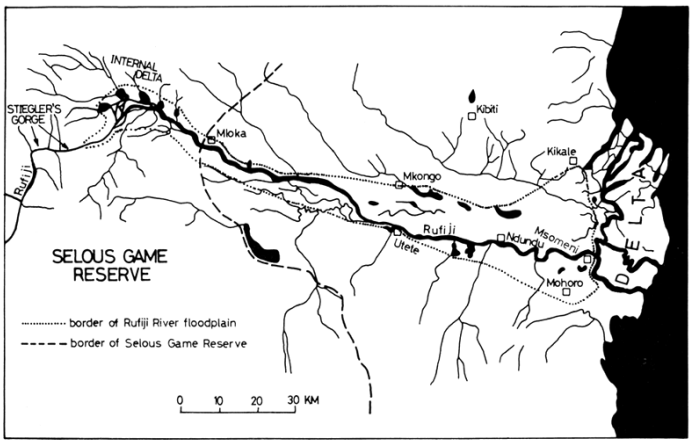

Figure 15 The Downstream of the Gorge. Source Rubada

Ecology

In the Selous

The Selous Game Reserve game reserve is one of the world's largest and significant protected areas. The dynamics of the Rufiji River make the area downstream of the gorge, the richest habitat area with the largest concentration of fauna and flora. Here the river spreads out in large meanders, also filling lakes and wetlands. The Rufiji at the Gorge has been minimally affected by upstream dam-building on two of its three main tributaries, meaning that it still maintains a dynamic, seasonal

Figure 16 Downstream Lake. Source Author

cycle[63]. This involves maintenance of water in a core area of river and wetland, leaving a drained strip of fertile and watered land that is seasonally covered by lakes and rivers. These belts of wetland and more tropical vegetation give the Selous much of its ecological richness and thus OUV[64]. The Rufiji also fills and extends lakes such as Lake Tagalala and Lake Manze. These lakes are fed by rivers coming from the Udzungwa mountains but can evaporate entirely in the dry season, making them dependant on the annual flood[65]. Generally, these wetland areas around the river are ecological hotspots, with animals migrating to the water in the dry season[66]. Endangered species using these areas include the Elephant Shrew, two flapped chameleon species, wild dog, rock pythons, black rhino's and elephant[67].

The seasonal pulse of the river is therefore of great importance to the Selous Reserve's ecology: It creates a wide strip of richly fertile and irrigated water; reconnects or fills lakes replenishing their fish stocks and fertility and supports wetlands[68]. The biodiversity of this habitat makes it the focal point for the reserve and underpins the Selous' claim to OUV.

Figure 17 Downstream Wetland

[63] Hamerlynck et.al., 2010; Duvail et.al. 2014
[64] Baldus, 2009
[65] Hamerlynck et.al., 2011
[66] Baldus, 2009
[67] Arms on Environment, 2013
[68] Hoag and Ohman, 2008; Hamerlynck et.al., 2011; Duvail and Hamerlynck et.al., 2007

Delta

A similar pattern can be observed outside the reserve. Flood events have over time changed the course of the river, creating 6 large ox-bow lakes outside the reserve that provide rich habitat[69]. These lakes are only reconnected to the river in seasonal floods, and often remain unconnected in years of drought. The interruption of biotic material leads to significant decreases in fish numbers and biodiversity loss. Duvail et. al. (2014) study indicates that dam's capacity of delivering 2500m^3s^{-1} in the rainy season, would cap flood peaks, causing lakes Manza and Uba would dry out, Umwe to be disconnected and become highly saline and the remaining Ruwe, Zumbi and Weme lakes would have height decreases.

The delta region more widely is supported by the seasonal river, primarily because it brings quantities of sediment which maintain the delta against sea erosion, a factor which will increase in

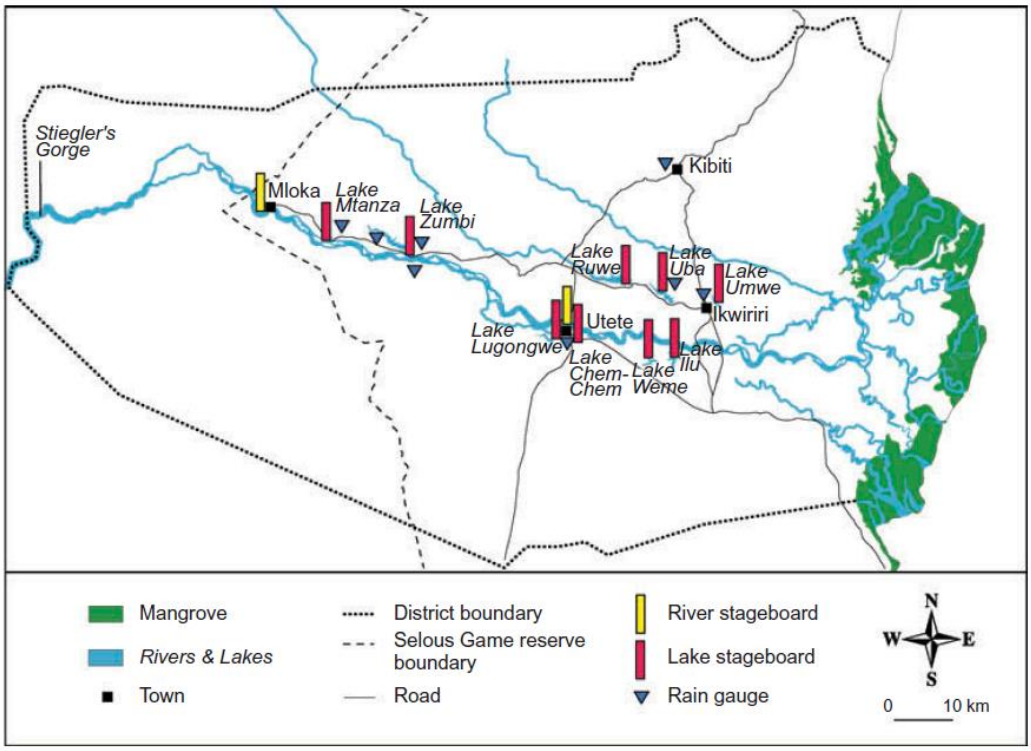

Figure 18 Detailing the Lakes, Delta and measuring stations. Source Duvail et.al., 2014

importance with sea-level rise[70]. The pulse of river water also maintains the present dynamic salinity levels, which again have implications for fauna and flora[71]. For instance, changes in the salinity will affect the mangrove stand there, currently the largest in East Africa[72]. The delta and the off-shore stretch to Mafia island can also be considered significant in terms of large populations of resident and migratory fauna. Many of these are linked to the river's seasonality with prawns spawning and whale sharks visiting in response to the river's seasonal sediment pulse[73]. The delta also is home to endangered species including five species of turtle and the Dugong[74]. The collective ecological importance is highlighted by the area being designated a RAMSAR site (Rufiji-Mafia-Kilwa Marine RAMSAR site).

[69] Hamerlynck et.al., 2011
[70] Mwalyosi 1998, Hamerlynck et.al., 2010
[71] Brown et.al. 2016
[72] Brown et.al. 2016
[73] Mwalyosi 1991; Mwalyosi 1998
[74] Arms on Environment, 2013

There are risks that the Stiegler's Gorge Dam will therefore harm this environment:

- A more regularised flow, with lower or no flood peak, and a reservoir blocking sediment entails:
    - Undermining wetland and seasonally flooded habitat
    - Reduced or suspended connectivity between lakes
    - Reduced water and fertility ecosystem services to agricultural land
    - Salinity intrusion into the delta

However, the environments listed are not just at risk from this project. Existing threats stem from natural resource exploitation, insufficient institutions, poor management, poaching, corruption and the poverty in local communities[75]. Conversely, the Stiegler's Gorge could represent an opportunity to increase money spent on the Selous's management. Odebrecht has in fact suggested that a percentage of electricity sales should be spent in such a way[76]. This could be significant and indeed possible to ring-fence. However, as with the Escrow scandal in Tanzania, such ring-fencing attempts frequently fail in such a corrupt country. Moreover, it is important to note that money cannot alone compensate for the risks of the dam and that moreover, the Selous already generates significant revenue, the majority of which has been diverted to central government[77].

Figure 19 Three Photographs Showing the Varied Downstream Environment of the Selous

[75] Interviews 2015-16; Arms on Environment, 2013; Brown et.al. 2016
[76] Odebrecht, 2013a
[77] Baldus 2009; Interviews 2015-16

Socio-economic Impacts

The area immediately downstream of the project is the main tourist area of the park, containing the photographic tourist blocks. Dozens of luxury camps exist within the block and lower-end camps are situated just outside entry gates. The presence of the construction site and its associated infrastructure would be on one of the Beho Beho hills that run through the block. This could improve tourist access and limits the visual impact of the work-site. The construction process, roads vehicles and people would problematically reduce the wilderness feeling currently drawing over 16,000 tourists a year[78] . If there is a substantial loss of big fauna and bird wildlife from poaching or the dam's operation, this will also undoubtedly reduce the tourist economy.

An intimate link between ecologies and livelihoods in the delta mean that the ecological impacts outlined above have a socio-economic effect. The typical farming practises downstream of the Selous involve flood recession agriculture, with large plots being grown on the fertile and seasonally flooded plain[79]. As Hamerlyck and Duvail explain, "Although the occasional early flood peak, as was the case in December–January 1968, can lead to the destruction of the 'short rains' maize crop, and the even more exceptional late flood peak, such as the one of May 1974 can destroy the rice crop, these events are rare and are, in general, compensated by excellent conditions for flood recession farming and also by a very productive fishing season"[80]. In fact, without a flood, land yields reportedly decrease by half in three years[81]. The population here also depends on fishing in the six ox-bow lakes below the reserve. As indicated above, even if an annual mitigation water release occurred, these lakes would be significantly reduced and suffer fish losses. Duvail et.al. (2014) predict that this will push the population into unsustainable logging and charcoal production as well as poaching, as happens already in years of drought. The mangrove stand and delta forest provides an important resource and the off-shore marine area is reputedly Tanzania's richest fishery, including a substantial prawn population (80% of the country's prawn catch originates here)[82].

Thus, whilst the project has the advantage of requiring very little – if any – physical displacement and resettlement, it would have important social consequences for the livelihoods of about 200,000 people downstream, and some people – such as fishermen – upstream[83]. This trade-off needs to be acknowledged. Additionally, the capacity to adequately engage affected people in mitigation and compensation should be demonstrated by the government and project developers.

Figure 20 The Downstream Lake Environment: Source Author

[78] Arms on Environment, 2013
[79] Hamelyck and Duvail, 2007; Havenick, 1993
[80] Hamelyck and Duvail, 2007, page 40
[81] Hamelyck and Duvail, 2007
[82] Arms on Environment; Mwalyosi 1998
[83] Havenick, 1993

Conclusion

This overview suggests the project has significant ecological and socio-economic risks for an area of global ecological importance. The Environmental and Social Impact Assessment for this project will need to be extensive. It should include a strategic review that considers the gamut of the dam's effects in conjunction with other projects in the basin and be critically aware of the inability to mitigate impacts, thereby explicitly acknowledging trade-offs involved. The ESIA should also fully appraise the need for the project and alternatives in energy generation. Moreover, it should consider the impact on OUV, the viability of World Heritage Status and the consequent global significance of the project. It is plausible that, like with the upstream Kihansi and Malagarasi hydropower projects in Tanzania, new endemic species will be the discovered in the research involved in an ESIA.

It is important to note that many of the project proponents described above have failed to appreciate the scale of the potential impacts despite their well-documented by foreign and Tanzanian academics. Reports and many interviewed officials focused on the area being flooded behind the dam wall as the affected project area, rather than that on the whole river. The initial EIA by Arms on Environment, similarly seems to assume that the project impacts can be mitigated by a full EIA. Even if full mitigation is possible, it will likely involve alternative reservoir management that reduces power production, and thereby profit, by replicating annual floods. It is therefore important for the full extent of trade-offs to be appreciated so that an informed decision can be taken on whether the Tanzanian government and citizenry wish to proceed with the significant undertaking, knowing the risks at hand. Not least of these will be the World Heritage status of the Selous Reserve as UNESCO itself states the dam is incompatible with World Heritage Status.

Alternatives

Tanzania is endowed with a wide range of energy potentials capable of generating over 2100MW:

- Fossil fuels represent an environmental hazard, and the use of them for domestic power prevents their alternative lucrative export. Despite this, they are favoured by the current MEM strategy:
- Natural Gas:
    - Offshore: Recent discoveries of over 55tch of off-shore natural gas place Tanzania's reserves in the top 10 globally. Off-shore is likely to be too expensive to sell domestically
    - On-shore reserves exist, are being tapped for thermal energy, have a lower cost than off-shore and are relatively reliable and simply constructed. Currently on-shore gas is envisioned as Tanzania's main future energy supply.
- Coal potential exists in the South with the Kiwira project in the pipeline.
- Oil could potentially be supplied cheaply from neighbouring Uganda and Kenya. Tanzania has won the bid from Uganda to construct a pipeline to Dar es Salaam
- Renewables: With prices falling and large-scale application increasingly viable renewables are arguably capable of competing. Proponents argue renewables offer an appropriate technology for sustainable development and electrification, with a potential to produce power remotely, for micro-grids and in quantities appropriate for low users.
    - Solar resources: On grid potential and Tanzanian private sector solar market grown in last two years.
    - Wind: Significant potential in Singida. Tanzania's first on-shore, on-grid wind farm of 100MW is hoped to be completed before 2020.

    - Geothermal: Large potential exists in the rift valley. Neighbouring Kenya aims to have developed over 5000MW. Tanzania has yet to conduct detailed studies but experts suggest likely potential.
    - Micro-hydro. A large potential known but not studied in detail and insufficient path to implementation created.
- Importing power: Opportunity in nascent and institutionalised Eastern African Power Pool from Kenya, with its large geothermal potential discovery, and Ethiopia, whose dam building program has an explicit rationale to export power. Both electricity sources are competitive with present system costs in Tanzania and a 400MW deal with Tanesco and Ethiopian authorities has been reported in 2016[84].
- Large scale hydropower. In the Rufiji basin:
    - Ruhudji dam 358MW, in sparsely populated upper reaches of one of the Rufiji's tributaries. It has had technical and environmental planning and World Bank support.
    - Mnyera project of 670MW. Developed by another Brazilian company Queiroz Galvao with an existing Rubada MoU. 6 individual hydropower sites to be built in stages to ensure bankability and feasibility. Initial design, feasibility and EIA complete. Hydrology data being collected.
    - Rubada has identified Iringa and Mpanga sites.
    - Tanesco is pursuing Malagarasi (45MW) Rumakali (222MW) and Kakono (87MW) hydropower projects all of which have had feasibility studies and are in various stages of gaining environmental approval.

Thus a wide range of technological alternatives exist, many of which are also renewable. Whilst not on the same scale as the Stigler's Gorge, their smaller size is arguably more appropriate to Tanzania's uncertain energy-demand, thus avoiding the financial risks associated with a large, single energy project. They can be argued to have lower socio-environmental impacts.

Additional Research

The Stiegler's Gorge project and Rufiji delta are relatively well researched areas. The studies detailed below and past environmental impact assessments have generated a relatively good understanding of the key features of the valley's socio-ecology and risks associated with the dam. Academics have looked at the historical and political aspects of the Selous and Stiegler's and a number of surveys of people living downstream of the park exist, although not always explicitly linked to considering the Stiegler's potential impact.

Further detailed ecological research on fauna and flora in the Selous and downstream delta would be needed and should be a part of any EIA, to enable fuller knowledge of the complete species and ecological dynamics present.

The combined impacts of multi-exploitation of the park remain understudied. Mining and fossil fuel exploration licences have been granted and a uranium mine is planned. These projects are unlikely to change the impacts that a dam would have by itself. However, the combination of environmental impacts, construction activities, presence of people and infrastructure collectively question the Selous' very existence. Additional impacts on the delta RAMSAR site remain unknown.

[84] http://africa.cgtn.com/2016/09/02/tanzania-inks-multimillion-dollar-power-deal-with-ethiopia/
http://www.sudantribune.com/spip.php?article60064
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THE STIEGLER'S GORGE HYDROPOWER PROJECT

RAPID ASSESSMENT OF RISKS TO THE SELOUS WORLD HERITAGE SITE AND THE RUFIJI-MAFIA-KILWA MARINE RAMSAR SITE

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Assessment Protocol

The Stiegler's Gorge Hydropower Project:
Rapid Assessment of Risks to the Selous World Heritage Site and the Rufiji-Mafia-Kilwa Marine Ramsar Site

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Briefing Paper for WWF
February 6, 2017

This paper describes the concerns for the integrity of the Selous and Rufiji-Mafia-Kilwa sites from the Stiegler's Gorge project and provides a rapid risk screening, based on currently available information and on the author's knowledge of the area and experience with comparable projects.

Background

The 50,000 km^2 Selous Game Reserve (SGR) is one of the most important protected areas in Africa, and has been recognized as a World Heritage Site since 1982. It is managed as a IUCN category IV (habitat/species management) area, by Tanzania Wildlife Authority (TAWA), with no permanent settlements but controlled hunting and tourism use. Before the current poaching crisis, the SGR provided habitats for the largest numbers of elephants, lions, wild dogs, buffalo, hippos and other species on earth. In 2014, the SGR was inscribed by the World Heritage Committee on the List of World Heritage in Danger. The threats from poaching are exacerbated by industrial development plans, including mining, oil and gas exploration, and dams for water supply and hydropower, as well as associated roads, camps, quarries and transmission lines. A boundary modification was approved by the Committee in 2012, reducing the size of the SGR by 200 km^2, to allow a uranium mine to go forward.

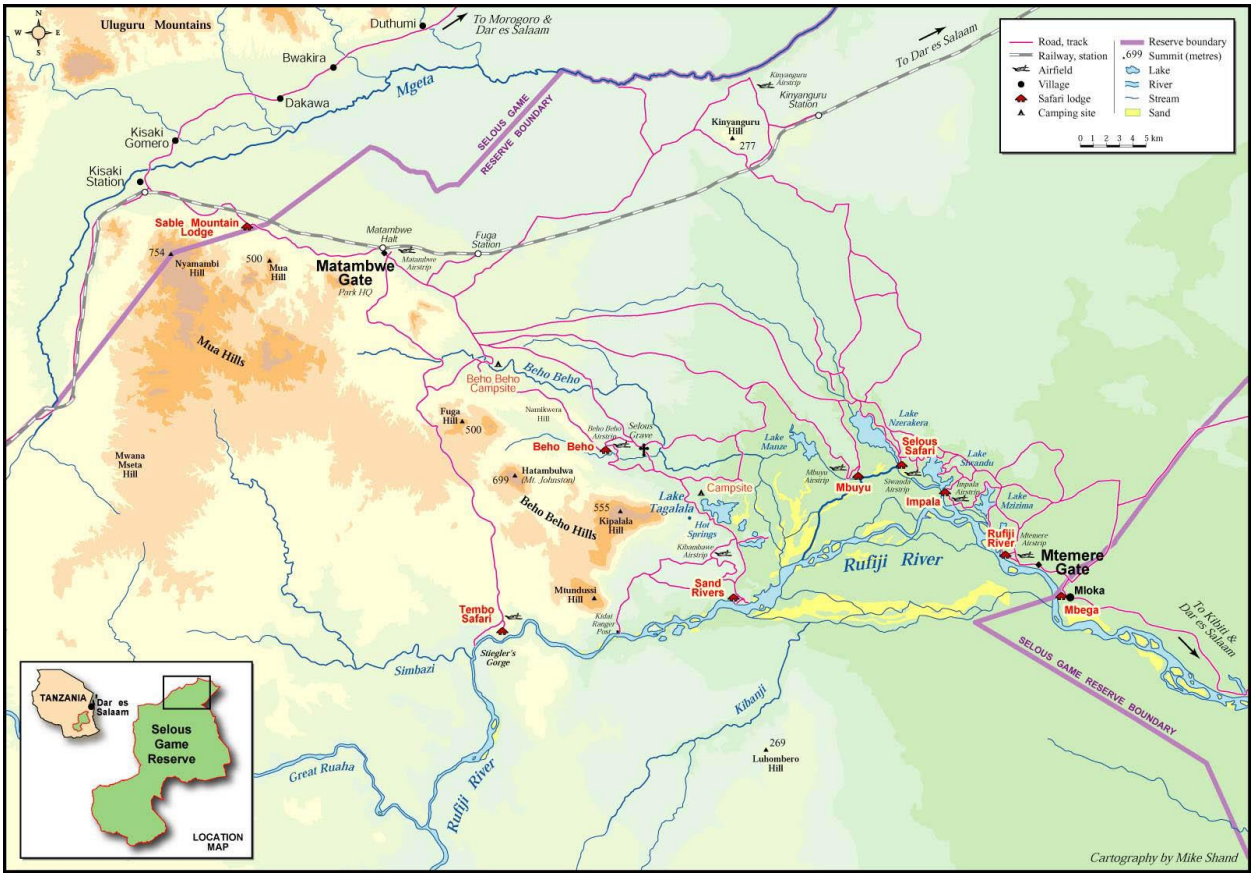
According to the 'Operational Guidelines for the Implementation of the World Heritage Convention', Tanzania as the responsible State Party should inform the Committee of any plans that would affect the Outstanding Universal Value (OUV) of the heritage site. The Committee has repeatedly requested the Tanzanian government to provide information on a particular project, the Stiegler's Gorge dam.

The Stiegler's Gorge dam site is located in the northern part of the SGR, 180 km upstream of the Indian Ocean. The gorge is about 8 km long and 100 m deep. The site was first identified in the 1950s, as part of the first survey of the water resources of the Rufiji River basin, Tanzania's largest river basin. The 1950's and 1960's saw significant interest in developing large scale water resources infrastructure in Africa (for example, Kariba, Akosombo and Aswan dams). Studies on Stiegler's Gorge were prepared with foreign support, but construction was postponed several times, while Tanzania developed smaller dams upstream in the Rufiji basin and in other parts of the country. Interest in Stiegler's Gorge returned in the 2000s, when private companies approached the government with offers to develop the dam and help resolve the power supply deficit. Stiegler's Gorge could more than double power supply

capacity in Tanzania. Since 2011, the government has been negotiating with Odebrecht, a large Brazilian hydropower developer and contractor.

The International Council on Mining and Metals (ICMM), with 23 leading companies, declared a commitment in 2002 to not explore or mine in World Heritage Sites. Unfortunately, smaller mining companies as well as hydropower companies have not joined that commitment.

Image 1. The northern Selous Game Reserve, showing Stiegler's Gorge



Downstream of Stiegler's Gorge the Rufiji River reaches the Rufiji-Mafia-Kilwa (RFM) Marine Ramsar Site, a 5,969 km^2 site designated by government in 2004 under the Ramsar Convention. The site includes the entire Rufiji delta (approximately 1,400 km², with 550 km^2 of mangrove forests), coastal areas south of the delta, the island of Mafia and the shallow coastal waters, islands and coral reefs in between.

Like the 1972 World Heritage Convention, the 1971 Ramsar Convention has a mechanism to address risks to a site. Each Contracting Party shall inform the Secretariat if "*the ecological character of any wetland in its territory and included in the List has changed, is changing or is likely to change as the result of technological developments, pollution or other human interference*"; such sites may be placed on a list (the Montreux Record); and Contracting Parties may invite a Ramsar Advisory Mission to analyze the situation and provide advice.

No such steps have yet been taken with respect to Stiegler's Gorge. However, the 2004 nomination of the RFM Ramsar site by the government stated: "*A large-scale plan for damming of the Rufiji River at Stiegler's Gorge…was prepared in the…1980s… The implementation of such a project at Stiegler's Gorge is envisaged to have severe impacts on the ecological balance downstream in the Rufiji Floodplain and Delta. The impacts will influence the biodiversity and people dependent on the natural resources in the floodplain and delta including the fishery along the coast of Tanzania."*

The only sanction available to the World Heritage Committee is the deletion of a site from the World Heritage List, if conditions deteriorate and OUV is no longer given. (Under the Ramsar convention, it is the government that would have to withdraw a site.) The status of discussions between the government and the World Heritage Committee is as follows:

The 2013 IUCN Reactive Monitoring mission provided an early analysis of the project. It noted that the EIA planned at the time was likely to be insufficient to clarify the following risks:

- *"Risks of decreasing water supply due to natural change and/or increasing upstream abstraction, in addition to increased evaporation from dam reservoirs;*
- *Sedimentation in the reservoir as a challenge to long term economic viability;*
- *Floating alien invasive plants could cover the reservoir, bringing maintenance concerns and pollution risks associated with possibly necessary chemical control. If chemical control is not applied, the floating invasive alien plants would affect water quality and increase the rate of water loss due to transpiration;*
- *Eutrophication of the reservoir;*
- *Loss and direct impacts on terrestrial habitats through flooding of the upstream river, including rare canyon habitats and important habitats for critically endangered species such as Black Rhinoceros;*
- *Disturbance during construction and maintenance of dam and associated infrastructure and social and environmental effects of construction towns, possibly aggravated by migrant fishermen likely to be attracted by the vast reservoir;*
- *Fragmentation and disturbance through road infrastructure and transmission lines;*
- *Loss of nutrient and mineral rich sediments downriver with effects on agricultural productivity and food security but also river morphology and erosion, including in the ecologically and economically important delta;*
- *Disruption and modification of downstream flow patterns through controlled water release differing from natural patterns, including in the floodplains which constitute some of the richest habitats for wildlife and are the basis for non-consumptive tourism in SGR;*
- *Secondary impacts related to "door-opener" effect of new road access to dam, saddle dykes and transmission corridors, such as in-migration and illegal resource use, including elephant and rhinoceros poaching. Colleagues consulted during the mission suggested a surge in poaching during the operations of the field camp near Stiegler's Gorge in the 1980s;*

- *In addition, roads, construction, disturbances and the transportation of building materials will also provide pathways and ideal disturbance sites for introducing more invasive alien species;*
- *Reputational risk for consumptive and non-consumptive tourism in one of the last remaining large-scale natural areas and resulting potential negative economic impacts given the importance of tourism for the national economy;*
- *Effects on river, delta and marine fisheries through impacts on fish migration and reproduction in the basin and the mangrove areas of the delta*."

The mission therefore made the following recommendations:

"*<u>Recommendation 11</u>*
The State Party should unambiguously and in writing clarify the current status of planning and decision-making regarding the Stiegler's Gorge project.
<u>Recommendation 12</u>
Given the potential serious negative impacts on the OUV of the property, the State Party should ensure a comprehensive understanding of the impacts, risks, costs, benefits, and alternatives as a basis for any decision-making regarding the Stiegler's Gorge Dam both in the form of an in-depth EIA and a comprehensive SEA…, taking into account the OUV of SGR. In line with paragraph 172 of the Operational Guidelines, these assessments should be submitted to the World Heritage Committee for review, before any final decision on the project is made.
<u>Recommendation 13</u>
The World Heritage Committee should call on States Parties to the Convention and private sector companies considering technical or financial support or involvement to the proposed Stiegler's Gorge project, not to take any investment decision before it has been demonstrated that the project can be implemented without negatively affecting the Outstanding Universal Value of the property. State Parties concerned should be reminded by the World Heritage Committee of Article 6.3 of the World Heritage Convention which stipulates that each State Party not "take any deliberate measures which might damage directly or indirectly the cultural and natural heritage (...) on the territory of other States Parties (...)"."

In its February 2016 State of Conservation report on the Selous, government stated: "*The State Party will observe the conditions of Paragraph 180 of the Operational Guidelines of UNESCO [definitions of dangers to natural heritage sites, including 'construction of reservoirs which flood important parts of the property'], and comply with national environmental management laws during the development of this project. However, in the wake of the available alternative energy sources (from gas and coal) in Tanzania the Government will develop these alternative energy sources for hydroelectric power generation if the environmental impacts of damming the Stiegler's Gorge will be beyond mitigation*."

In response, the World Heritage Centre and IUCN prepared the following analysis and recommendation to World Heritage Committee, for its 40th session in July 2016: "*It should be recalled that the Committee … expressed its utmost concern that the Stiegler's Gorge project, if approved, could cause serious and irreversible damage to the property's Outstanding Universal Value (OUV), and that the 2013 mission recommended the State Party to, clarify unambiguously*

and in writing the current status of planning and decision-making regarding the project. However, such clarification has not yet been provided... It is recommended that the Committee reiterate its request (Decision 37 COM 7B.7) to the State Party to undertake a Strategic Environmental Assessment (SEA) in order to comprehensively identify the cumulative impacts of mining, the Stiegler's Gorge and Kidunda dams, agriculture and associated infrastructure, such as road building, both within the property as well as in important wildlife corridors and dispersal areas that are critical for maintaining the OUV of the property."

The Committee then reiterated its "*utmost concern about … the high likelihood of serious and irreversible damage to the Outstanding Universal Value"* and requested that government invites another IUCN Reactive Monitoring mission to evaluate the impacts.

This mission is planned for February of 2017, and this brief is intended to summarize the current information (or lack thereof) on the environmental and social impacts of the Stiegler's Gorge dam, for consideration by the mission team.

As the previous mission noted, "*the debate and process could benefit from the evolving international debate surrounding large dams… it seems outdated and unhelpful to frame large dams as a development versus conservation scenario*." Current best practice is to carefully evaluate the need for and alternatives to proposed dams, understand their negative and positive impacts including cumulative impacts, and choose sites, designs and operational rules to minimize risks and maximize opportunities.

Key sources on engineering and environmental aspects of the project: 2013 reports

The Stiegler's Gorge project is a strategic development decision for Tanzania. Despite decades of discussion, very limited information is available to support that decision. It is ironic that the key documents used for this review:

- Odebrecht 2013 - Stiegler's Gorge Hydropower Project - Report and Proposal for Development, and
- Arms on Environment 2013 - Situation Analysis Report of Initial Scoping Process of the Stiegler's Gorge Hydropower Project

are not publicly available, and neither are any other documents associated with the Odebrecht project, despite Odebrecht's statement that the project should "*establish a participatory, transparent, and effective communication and information system through which local populations, Government, and other stakeholders can access data and information regarding the project and contribute with suggestions and critiques to improve plans and programs".*

Odebrecht describes the engineering proposal as follows:

- Concrete-faced rockfill dam (CFRD) on the Rufiji river with a maximum height of 126 m and 700 m in crest length, and 4 saddle dams with a total length of 13.9 km closing the southern limit of the reservoir, forming a 1,200 km^2 large reservoir with 22 billion m^3 (bcm or km^3) of live storage

- Volume of main dam 5 million m^3, and of saddle dams 6.1 million m^3, partially from excavations (dam foundations, spillway, tunnels, powerhouse caverns – total of 8.7 million m^3) and partially from quarries
- During construction, coffer dams as well as river diversion tunnels on the left bank, one of which will later be adapted as bottom outlet with 500 m^3/s capacity
- Gated spillway next to the dam on the right bank, dimensioned for discharge of Probable Maximum Flood (PMF) inflow of 20,000 m^3/s
- Intake tunnels leading to two underground symmetrical powerhouses, one on each bank, with 4 units of 262 MW each or a total of 2,096 MW, and tailrace tunnels leading back to the river
- A 400 kV, 200 km transmission line for each powerhouse
- 233 km of roads to the left and right bank construction sites

There are no concerns over the ability of Odebrecht to design and build a safe and functional project along these lines, as they have done in several other projects, including larger and more challenging ones.

The original 1980 proposal by Norwegian consultants, subsequent reports and the 2013 Odebrecht report, all call for implementation of the powerhouses (and possibly of reservoir filling and saddle dam construction) in stages. The total cost is slightly higher than if the entire project is built in one stage, but by building in stages the project's output can be better adapted to the growth in power demand. Also, the probability of having enough water to run one powerhouse is higher than for two powerhouses, and hence 74% of the firm power is generated by the first powerhouse.

To understand the influence of the large reservoir on river flows and power generation, it has to be seen from a comparative perspective. The Stiegler's Gorge reservoir is far larger than any previous reservoir in East Africa, but would not be exceptionally large for its river. Live storage in the reservoir would amount to 88% of the average annual flow. This would allow capturing seasonal high flows, and storing them for the low flow season. But it would not be sufficient to regulate inter-annual variations (i.e., take water from 'wet years' into drought years). As known from other, even more highly regulated African rivers, with similar flow variability, the highest floods and the most serious droughts can only be mitigated, but not avoided.

	Average Annual Flow at Mouth	Total Storage	Live Storage	Degree of Regulation
Zambezi River / Kariba & Cahora Bassa Dams	107 km^3	236 km^3	121 km^3	1.13
Nile River / Aswan Dam	89 km^3	162 km^3	131 km^3	1.47
Volta River / Akosombo Dam	38 km^3	148 km^3	60 km^3	1.58
Rufiji River / Stiegler's Gorge Dam	25 km^3	34 km^3	22 km^3	0.88

Regarding flood control, for example, the PMF at Stiegler's Gorge would fill a completely empty live storage within 13 days. In practice, because Stiegler's Gorge is not a flood control reservoir, a flood would not encounter a completely empty reservoir. If a flood of 20,000 m^3/s occurs at a reservoir water level of 186 masl, the reservoir level can rise to 188.5 masl within a few days.

After that, the reservoir cannot absorb additional flood waters and needs to pass them through the spillways. Assuming a flood rising and falling within approximately 10 days, the peak outflow is reduced to 16,000 m^3/s.

The reservoir can be expected to perform as follows:

- Significant seasonal variations in reservoir water levels, exposing hundreds of km^2 of mudbanks in the dry season
- No short-term variations in water levels (as the reservoir is too large to respond to slightly varying inflows, or slightly varying water releases, as power generation follows power demand between daytime and nighttime, and between weekdays and weekends)
- Significant evaporation from reservoir surface (for comparison, the reservoir covers $1/5^{th}$ of the area of Lake Nasser, which loses 10-16 km^3 of water per year to evaporation)
- Reduced larger floods, and eliminated smaller floods. An annual controlled flood release for environmental purposes of 2,500 m^3/s may be planned, although this is unclear in the documentation.

Odebrecht's chapter on the preliminary environmental and social evaluation formulates high objectives, including achieving positive environmental and social impacts, complying with IFC performance standards, and conducting a SEA. Achieving such high objectives would be difficult under any circumstances. It is made more difficult in this case, by

- A lack of capacity and experience in modern best practices in sustainable hydropower development, in Tanzanian government institutions and Tanzanian environmental consultancies, such as the one hired by Odebrecht for the environmental assessment;
- The fact that the engineering design is done before the EIA, leaving limited room for the avoidance and minimization of impacts;
- The fact that the entire project infrastructure is within a high-value protected area, and additional impacts are expected on a high-value protected area downstream.

Odebrecht initially contracted with a Tanzanian environmental consultancy, Arms on Environment, for a scoping report for the EIA. This firm is officially registered as an EIA consultant and has done EIAs for other hydropower projects before. Nevertheless, the scoping report is of poor quality. No additional engineering and environmental documents have been shared with the public since 2013.

A number of Tanzanian academics have also published papers and reports which cover the environmental impacts of the Stiegler's Gorge project, but in the absence of specific information on the siting, design and operations of the project, often remain vague.

Expected Impacts

A number of impacts can reasonably be expected from the Stiegler's Gorge project, on the SGR and the RFM Ramsar Site. Although most of the discussion of impacts to date has focused on the Selous, the downstream impacts are included here because they are functionally related to the Selous, and because they are ecologically relevant in their own right.

The focus here is on ecosystem and ecosystem services degradation which would pose a risk for the OUV of the SGR and for the value of RFM as a Ramsar site. (There are additional risks for Tanzania, which are not included here because they are not relevant to the protected areas.) The screening is based on currently available information specific for Stiegler's Gorge, the author's knowledge of the area, and precedents from comparable projects. The impacts are ordered from upstream to downstream.

Impact	Description	Mitigation Options	Level of Concern after Mitigation
Reduction in aquatic biodiversity and abundance above reservoir	Some species are dependent on migration past Stiegler's Gorge, and would be stopped by the dam and the reservoir with unfamiliar low velocity flows	In practical terms, none. No upstream fish passage could be designed for this high dam, and in any case, fish that could pass the dam would have to navigate an unfamiliar lake environment. Catch and release is unlikely to be practical. Downstream passage as larvae depends on flow velocity, and as adult fish on mortality in turbines	**Medium**. Fish biodiversity and life cycles are poorly known, but no major migrations have been reported. Little concern for upstream fishery productivity (not an important source of protein today, and new species may take ecological niches left by migratory fish)
Changed fish community in reservoir stretch of the Rufiji	The reservoir will provide habitat for different (and possibly non-native) species. Total biomass may increase, typically with an initial spike, and river species may be displaced. RUBADA speaks of 3,700 tons/year permanent yield, and 20,000 tons/year initial yield, primarily of tilapia.	In principle, research could be conducted to select desired fish species, and a managed fishery could be established. But introduction is difficult to control, and establishment of fishery and presence of fishermen potentially conflicts with conservation objectives	**Medium**. Unclear whether high productivity fishery could be established, even if fish are introduced; also unclear whether Tanzania could effectively control entry of fishermen
Sediment deposition at top of reservoir	Large amounts of sediment will settle out once the Rufiji slows down, possibly	In practical terms, none. In some reservoirs with high-value navigation, dredging is carried out. Deposition	**Low**. No particular interests at tail end of reservoir, and very long reservoir

	creating environmental nuisances and backwater effects.	will take many decades before it affects storage space.	lifespan.
Eutrophication & invasive aquatic plants	Nutrients coming into reservoirs and high temperatures may induce high primary productivity, algae blooms, and plant pests. These can cause water quality issues and operational problems at hydropower station, but are unlikely to increase evaporation.	Initial spike in primary productivity inevitable, and invasive plants such as hyacinth and fern likely, but manageable through low-tech mitigation (plant removal near intakes), probably not requiring chemical treatment.	**Low**. Overall level of nutrients and organic materials in river inflows, soils and vegetation is limited; like most large reservoirs and natural lakes in East Africa more likely to be oligotrophic.
Stratification of reservoir and GHG emissions	Reservoir will emit CO_2 and CH_4 at higher rates that the ecosystems that it replaces, particularly if stratification into different layers occurs	In practical terms, none.	According to the UNESCO/IHA risk screening tool, **medium** risks of significant GHG emissions
Water quality	Under special conditions, water quality can be impaired by pollution of rivers, along shores, by atmospheric deposition, or by release of soil compounds (for example, mercury)	In practical terms, none.	**Low** because of low human populations and large capacity of dilution and self-purification
Evaporation	Large water surface area increases evaporation rates; quantities will be significant	Keeping the reservoir as empty as possible; diking off shallow reservoir arms	**Medium**. Reduces power generation and downstream water use accordingly, may lead to increased salinity in delta, minor impact on microclimate

Shoreline wind erosion	Large exposed mudflats and sandbanks during the dry season can lead to dust storms.	Keeping the reservoir as full as possible	**Medium**. Very large areas may be exposed. Dust storms may be a familiar natural phenomenon in area, but would increase because of unconsolidated soils with no vegetation cover
Inundation of terrestrial habitats	For comparison, 1,200 km^2 of wildlife habitat is larger than the majority of Tanzanian national parks. Terrestrial biodiversity and abundance of animals is large, because of the variety of land forms and habitats; the availability of food and water; and the large extension and remoteness. The Selous provides globally significant habitats for charismatic and endangered species; there is no information on species endemic to the project area.	Compensation by managing remaining habitat better and/or by expanding Selous by equivalent habitats (biodiversity offsets, likely upstream or downstream along the Rufiji River, at least by the same amount lost to the project)	**High**. For various reasons, compensation is unlikely to be feasible (lack of political will to use available resources for better management, lack of replacement land, irreplaceability of Rufiji ecosystem). Effects on internal migration routes uncertain, animals will adapt to some extent. Impact on migration corridors outside the Selous unlikely.
Increased access by poachers	Poaching is facilitated by access to the reserve and within the reserve created by permanent and temporary roads. Poachers are still using tracks created by oil	Depends largely on political will to allocate resources to anti-poaching operations, and to reduce demand for ivory and other resources	**Medium**. Could be managed with effective entry control system to the reserve, and surveillance within the reserve, supported by

	exploration in the 1970's. The main access road is expected to be 120 km long, from Chalinze.		project funds; however Tanzania has poor track record in this regard
Temporary pressure on wildlife, firewood etc. by construction workers and camp followers	If camps are not self-contained, workers several thousand for a project of this scale) and camp followers will use natural resources	Depends largely on willingness and ability of contractors to enforce control over work camps, and camp followers	**Low**. Odebrecht has shown ability to run well-managed camps; low need for permanent operational staff
Land disturbance for roads, transmission lines, camps, industrial areas, quarries, spoil deposits etc.	Opening an industrial site can cause land disturbance on a major scale, which can take decades to heal in a dry forest and savanna environment.	Smart construction planning can minimize disturbance to some extent (for example, quarries in future reservoirs, reuse of excavated material in saddle dams or for landscaping, land rehabilitation with native species). Some areas will remain permanently disturbed, but infrastructure can be sited and designed to minimize impacts on high-conservation value areas.	**Medium**. Odebrecht has shown ability to minimize construction impacts, but some permanent impacts are unavoidable.
Temporary air, noise, solid waste, and wastewater impacts	Construction traffic, machinery, camps can generate significant amounts of pollution	Modern, well-operated machinery and vehicles, and well-managed camps and industrial sites with wastewater treatment and waste disposal can reduce impacts	**Low**. Odebrecht has shown ability to minimize construction impacts. Animals will avoid areas temporarily but return, as they do to tourist camps.
Reduction of attractiveness to tourists	Photo and hunting tourists are the main sources of revenue for the management of the Selous, and an important economic	Minimization of disturbance, as described above, will also reduce impacts on tourists. Alternative sites may be developed for tourists, and	**Medium**. The Selous is currently visited by less than 1% of visitors to Tanzania, and the dam site and

	factor for Tanzania, and may be deterred from visiting the area, which loses its character as the last remaining large wilderness. The northern area, where Stiegler's Gorge is located and which is easier to access, is largely allocated to photo tourism. Photo tourism is a small industry, with only 248 beds in the northern camps, but has growth potential. Tourism near the dam site may partially recover once construction is finished. But tourism along the lower Rufiji lakes and in coastal areas might suffer increasing damage over time.	road and services improvements will provide some benefits.	reservoir area are difficult to access and not currently high on the tourists' agenda. However, the tourist potential of the Selous is high, and the discussion on the project and the possible loss of the World Heritage status will deter tourists. Also, downstream areas of high attractiveness will be impacted (for example, lakes that depend on annual flow pulses).
Short-term fluctuations in flow releases	Due to its unique role in the power system, Stiegler's Gorge will have to provide both base load power and peak load power. During normal operations, flow releases will therefore vary with power demand. This may lead to sudden water level rises and drops below the dam.	Ramp-up and ramp-down rules determine how quickly river levels can be changed.	**Low**. Limited impact because Stiegler's Gorge is likely to be operating continuously to supply base load, and because river valley broadens below Stiegler's Gorge, so that any increases in water levels dissipate.
Reduction in seasonal	The reservoir will eliminate smaller	In principle, the reservoir can be operated to mimic	**High**. Combined with the lack of

variability of flows	floods and reduce larger floods. This will reduce the ability of the downstream river to transport sediment, shape the river channel, connect to oxbow lakes within the Selous as well as in the downstream floodplain, and maintain the natural dynamics of the delta. Low-flow periods (which may be important, for example, to expose sandbanks for use by reptiles) will also be eliminated.	natural variability of flows. Keeping the reservoir full at all times means that inflows equal outflows, the reservoir is essentially operated as run-of-river, and downstream flows are unchanged from natural conditions. However, in practice, the generation gain from increasing the head is overcompensated by the generation loss from spilling and evaporation, and run-of-river operations are therefore commercially not viable.	sediments (described below), the reduced variability will significantly affect the natural dynamics of downstream freshwater and coastal ecosystems, and prime habitats of many species.
Reduction in sediment load and changes in geomorphology	Except for some fine silt which remains in suspension, initially no sediment will pass through the reservoir and replenish the downstream areas. The river downstream of the gorge will start eroding its banks and beds, and over time, will change its course, affecting human use and infrastructure as well as habitats in the floodplain and delta. The coastline is likely to retreat. Over time, trapping efficiency of the reservoir will diminish and more sediment will pass through.	Stiegler's Gorge has a bottom release which can be used to flush sediments from reservoir, but this requires emptying the reservoir and foregoing power generation. It is more likely that the bottom outlet would only be used for emergency drawdowns of the reservoir, and possibly in the very distant future when sediment starts affecting the intakes.	**High**. Changes to downstream morphology are inevitable and may lead to major disruptions over time. The biggest unknown is how much sediment the river can re-mobilize by eroding the alluvial floodplain, before the effects reach the delta.

Reduction in aquatic biodiversity and abundance below reservoir	Changes in flow quantities and variability, water quality (primarily turbidity and salinity, possibly temperature), access to upstream river stretches for part of life cycles, and geomorphology will change habitat conditions for all aquatic organisms, including endangered species (for example, Dugong and sea turtles), subsistence fishing species, and commercially relevant species (for example, prawns and shrimps). The impact of changed turbidity and nutrient delivery on coral reefs in the Mafia channel is uncertain.	The cumulative impact of multiple changes listed above, will affect different species differently in ways that are impossible to predict, and it is unlikely that the reservoir would be operated to reduce impacts. There may be some mitigation and compensation measures to improve natural resource management and conservation in the floodplain, delta, and adjacent marine areas.	**High**. The Rufiji-Mafia-Kilwa Ramsar Site is of international importance, and even among Ramsar sites is unique for its combination of different tropical coastal ecosystems.
Reduction in ecosystem services for downstream inhabitants	Over 150,000 people inhabit the Rufiji Delta and floodplain, and another 50,000 the offshore islands. A majority rely for their livelihoods on the extraction of natural resources or on other activities dependent on ecosystem services (such as fishing, riverbank cultivation dependent on seasonal floods, and mangrove wood extraction for	The impacts originate in reservoir operations and subsequent biological and physical changes, but are too complex to be effectively managed. There may be some mitigation and compensation measures, as mentioned above. Protection from floods should not be overestimated, as large floods will still occur and the elimination of smaller floods may create a false sense of security. There are plans for formal irrigation	**High**. Given the pre-existing poverty and pressures on natural resources, household livelihoods and living standards are vulnerable to further disruptions.

	charcoal). Subsistence and small-scale commercial fisheries are important for protein supply. Poverty rates are higher than the national average.	schemes in the Rufiji, and these may be easier to implement with funds from the Stiegler's Gorge project and easier to operate with higher dry season flows, but will also be vulnerable to large floods. RUBADA speaks of 80,000 hectares as suitable for irrigated agriculture, producing 450,000 tons of paddy, 7,000 tons of maize and 3,000 tons of cotton. This appears overly ambitious, as the total area in large irrigation schemes in Tanzania is 61,000 ha, and the crop yield would be above global averages.	

Conclusions

Summarizing these impacts, in the view of the author there are two areas of high risks that are large scale; difficult, if not impossible to manage; difficult to understand on the basis of current information; and would need particularly careful consideration:

- Inundation of terrestrial habitats by the 1,200 km^2 large reservoir; and
- A series of downstream changes, starting with reductions in the seasonal variability of flows and in their sediment load, leading to changes in geomorphology, reductions in aquatic biodiversity and abundance, and finally reductions in ecosystem services for downstream inhabitants.

These risks are similar to those highlighted by Odebrecht themselves in 2013:

- "*Relation among reservoir size and the inundated area;*
- *Impacts of associated infrastructure;*
- *The large contingent of workers necessary;*
- *Potential impacts of the project in sediment transport and, consequently, on river morphology; and*
- *Aspects related to water quality*".

This author has fewer concerns regarding: temporary risks associated with the construction site (in case Odebrecht, a company with a good track record, manages the site), water quality risks (owing to the large flow and low population density upstream), and risks of associated infrastructure (as access roads and transmission lines, once built and as long as access to the

reserve is controlled, will have relatively small footprints). The qualification of some risks as 'low' and 'medium' in this screening exercise, assumes appropriate management measures.

However, the remaining two risks are very significant. It is unprecedented to risk losing the integrity of not one, but two globally significant protected areas to a hydropower project. Because of reputational risks, it is inconceivable that finance could be raised from investors and lenders following multilateral bank safeguards and IFC Performance Standards/Equator Principles, unless perhaps with massive mitigation and compensation programs designed specifically to maintain the Selous' OUV. Out of 1,052 World Heritage sites, only two have ever been delisted after losing their Outstanding Universal Value, the Dresden Elbe Valley in Germany (because of a bridge) and the Arabian Oryx Sanctuary in Oman (because of poaching, oil exploration and a 90% reduction in size).

In addition, there are some risks of cumulative impacts with other industrial land uses in the Selous, such as mining. While the Mkuju uranium mine is at a distance of approximately 300 km, at the southern end of the Selous, 34 mining concessions that overlap the Selous have been granted and a further 14 concessions have been applied for. There is active oil exploration in one overlapping concession where a sedimentary basin of interest overlaps with the Selous. The vast majority of these lie upstream of Stiegler's Gorge. In general, there is practically no publicly available information on planned exploration or exploitation, and its impacts. Cumulative impacts could be through water contamination, for example (the Mkuju mine is in the Luwegu sub-basin, upstream of Stiegler's Gorge), through direct impacts on land, and through indirect impacts of opening access by illegal resource users. Further use of water resources upstream of the Selous, principally through irrigation and hydropower development, could also lead to cumulative impacts. There is no tradition in Tanzania of considering large-scale cumulative impacts in project planning and permitting.

The 2013 Arms on Environment report suggests Terms of Reference (ToR) for a cumulative impact assessment, as well as for an environmental impact assessment, and an environmental management plan. These ToR show no awareness that the role of EIAs should be to critically assess siting, design, and operation alternatives of a project. They do not mention a series of risks identified in this screening exercise, such as reductions in tourism or downstream geomorphological changes, or opportunities such as biodiversity offsets. If these ToR have been used to guide further studies after 2013, there would be little confidence in their results. For all risks identified here, thorough baseline studies and impact prediction - including in a number of cases, quantitative modelling - would be required.

According to a 2013 Odebrecht presentation, it would be the role of RUBADA – presumably as the Tanzanian partner in a developers' consortium - to conduct the Environmental Impact Assessment and secure the approval of all environmental licenses. While Odebrecht has relevant experience, RUBADA has none, suggesting that they could not effectively quality control the EIA.

It is surprising that Odebrecht, although an experienced international developer with an awareness of environmental and social issues and the associated risks to a project, would rely solely on Tanzanian consulting firms and government agencies with little experience and conflicting interests to handle this side of the project. It is also surprising that the Tanzanian

government would put at risk protected areas of this quality, when there are multiple other power supply options, including other hydropower sites, with similar costs and lower risks.

IUCN, the UNESCO World Heritage Centre, and the Ramsar Convention Secretariat have an opportunity to assist the Tanzanian government in taking better care of these exceptional sites, and basing strategic energy development decisions on better information. The IUCN/UNESCO mission should encourage government to share the currently available information, in order to allow additional expert input, to open up a dialogue with the Ramsar secretariat, and to consider alternatives to Stiegler's Gorge.

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Joerg Hartmann works as an independent sustainability consultant, for power and water companies, banks, government agencies, and NGOs. He has worked in over 40 countries, has led many water and natural resource project appraisals and assessments, and served on expert panels. He provides advice on all aspects of sustainable water infrastructure development, from project selection and design, to stakeholder engagement, permitting, and access to finance. He was part of the Hydropower Sustainability Assessment Forum, which developed the Protocol, and is now an accredited lead assessor and has applied the Protocol in over 20 hydropower projects. From 2011 to 2013, he chaired the global multi-stakeholder Governance Committee of the Protocol. He is also an accredited consultant and trainer with the Alliance for Water Stewardship.

Previously, from 2007 to 2011 he led WWF's global hydropower and water security work, at the policy level and through WWF's river basin programs. From 1996 to 2007, he worked for Germany's development bank KfW, as a project and program manager first in Eastern Europe and then in Latin America. In his last three years at the bank, he was KfW's country director for Tanzania and chaired the water donors group, which pooled investment resources to reach Tanzania's MDGs on water. He holds a PhD in environmental and development economics, and lives in Colorado in the United States.

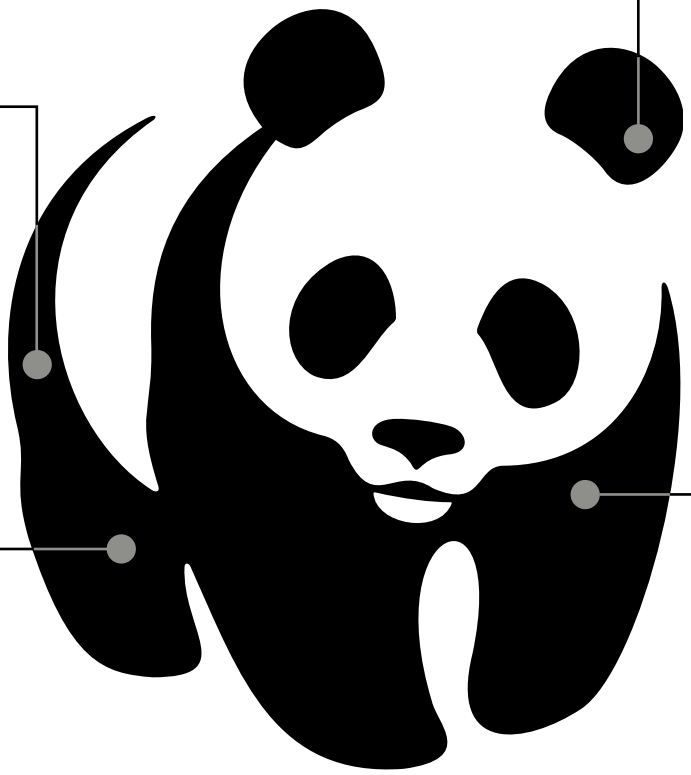
The true cost of power

200,000

The livelihoods that could be negatively affected by building the dam

180

The number of kilometres away that people will be impacted by the proposed dam



3

The number of globally important protected areas affected by building the dam

90%

Almost 90% of Selous elephants have been lost in the last 40 years

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