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Guinea Bissau

International Hydro Power Expert

Renewal/update of feasibility studies on small hydro sites from the 80es and development of a technical paper on the status and perspectives of the hydro power sector in Guinea Bissau

2013 Work Plan ID: INF.1 WP 2013

Mission Report

October 2013



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0 Abbreviations

a.s.l.	abovesealevel
COBA	COBA – Consultores de Engenharia e Ambiente, S.A., Portugal
ECREEE	ECOWAS Centre for Renewable Energy and Energy Efficiency, Praia, Cape Verde
GDRC	Global Runoff Data Centre
GEF	Global Environment Facility
GHG	Green House Gases
NGF-IGN	Metersabovesealevel ; based on French system (InstitutNational de l'Information Géographique et Forestière – IGN)
OMVG	Organisation pour la Mise en Valeur du fleuve Gambie
PAGIRE	Plan d'Action Régional de la Gestion Intégrée des Ressources en Eau
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
WAPP	West African Power Pool

1 Introduction

The ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) in close coordination with the United Nations Industrial Development Organization (UNIDO) is assisting the Ministry of Energy in Guinea Bissau in the development of the national hydro power sector. So far, the country is not taking advantage of the potential due to the existence of various technical, financial, policy, capacity and knowledge barriers. The assignment is linked to the ECOWAS Small Scale Hydro Power Program¹ and the GEF project "Creation of an Enabling Environment for Small to Medium Scale Renewable Energy Investments in the Electricity Sector"².

The chronic crisis of the electricity sector of the country represents a high cost for the entire economy, adversely impacting production costs and the population's standard of living. As long as the country continues to depend on expensive diesel-based electricity generation the situation will not improve. High generation costs, commercial and technical grid losses, as well as a small base of clients with a low ability and willingness to pay present a heavy burden to the local electricity and water company, as well as the Government. There is a rapidly growing gap between electricity demand and the available national generation capacity. Existing short-term development plans in the electricity sector are focused on the expansion of thermal plants without giving the hydro alternative respective priority in the least-cost analysis. Only a small part of the rural population has access to electricity services.

The economics of Small Scale Hydro Power (SSHP) and Medium Scale Hydro Power (MSHP) look very promising in comparison to the existing or planned diesel or heavy fuel oil (HFO) fired generators. The economics are even more promising when negative externalities of thermal plants (e.g. local pollution, GHG emissions) are considered. The use of hydro power would contribute significantly to the improvement of energy security, energy access and mitigation of GHG emissions. It can assist in meeting the peak load demand in the capital Bissau and provide access to electricity services in rural areas. It has the potential to reduce/stabilize the high electricity generation costs, consumer tariffs and the financial status of the public utility in the long-run. The reduction of dependence on imported diesel will free-up scarce financial resources for the Government, public utility, industry and private households.

Assessments have revealed that the rivers Corubal and Geba have significant hydropower potential. There is the need to renew and/or update the measurements and feasibility studies for the identified sites **Saltinho** (18 MW) and Cussilinta (32 MW) at the **Corubal** river. It is not clear whether the available hydrological data set is reliable (measurements from the 70s or 80s). The two sites are located around 170 km from Bissau and are nearby

¹ <http://www.ecreee.org/page/ecowas-small-scale-hydro-power-program-sshpe>

² http://www.thegef.org/gef/project_detail?projID=5331

the planned transmission line of OMVG from Guinea to Senegal. In the case of the **Saltinho** site comprehensive geological, hydrological and feasibility studies are available (in French). The hydraulic contribution of the Geba River seems to be more modest. The flow volume of the Geba River has been also affected by the construction of the Confluent and Niandouba dam on the Kayanga River. Both dams are only a few kilometres upstream of the Senegalese – Guinea-Bissauan border and located near the city of Kounkane close to the Anambé Forest Reserve.

In this context, UNIDO and ECREEE have engaged in contracting the services of a hydro power expert to review the available documentation on hydro sites with focus on the SSHP sites Salthino and Cusselinta and roughly assess potential small hydropower sites not studied or identified so far (e.g. at Rio Geba). It is foreseen, that the present evaluation will be integrated accordingly in the on-going preparation of the GEF project "Creation of an Enabling Environment for Small to Medium Scale Renewable Energy Investments in the Electricity Sector".

2 Team and Sequence

As foreseen by the ECREEE, the composition of the team besides the contracted consultant Rudolf Huepfl consisted of the two contact points (UNIDO/GEF – Julio Antonio Raul and ECREEE – Biabé Siga). When seeing the importance of hydrology, it was proposed by the local ministry to include also an expert from Water Resources. Due to budget constraints the proposed hydrologist could not participate in the field trip.

Date	Nr	Day	Destination	Task
17.09.2013	00	TUE	Vienna - Bissau	Travel
18.09.2013	01	WED	Bissau	Briefing and meetings
19.09.2013	02	THU	Bissau	Meeting with officials
20.09.2013	03	FRI	Saltinho&Chumael	Site visit& reservoir
21.09.2013	04	SAT	Saltinho, Surire&Cussilinta	Site visit
22.09.2013	05	SUN	CheChe&Cabuca	Reservoir area
23.09.2013	06	MON	Sonaca&RapidosManquerina	Site visit
24.09.2013	07	TUE	RapidosJansene	Site visit
25.09.2013	08	WED	Bissau	Meeting with officials
26.09.2013	09	THU	Bissau	Meeting with officials
27.09.2013	10	FRI	Bissau	Debriefing and meetings
28.09.2013	11	SAT	Bissau - Vienna	Travel

3 Meetings with key stakeholders

Supported by the national UNIDO/GEF focal point the following meetings have been conducted.

A list of meetings is provided in Annex A.

3.1 Ministry of Energy and Industry

3.1.1 Engº. Mario Adao Carlos ALMEIDA, Secretario de Estado de Energia

The meeting served mainly as joint briefing on target and program of actual study. There was a detailed discussion on the accessibility of intended places as well as information on first indication which part of old COBA studies will need additional works. They were preliminary identified as the environmental sector and socio-cultural issues.

3.1.2 Lamberto Soares Camara, Director Geral de Energia

The field trip and its details were discussed with the Director Geral de Energia. As a result of the discussion the travel route could be **optimized**. At the end of the mission, the team held an intensive de-briefing meeting with him. Missing information and data were discussed; special mention was done to the good support achieved from the various departments on one side and the **especial implementation during** field visit by the team in full rainy season on the other side.

3.2 Ministerio dos Recursos Naturais

3.2.1 Inussa Baldé, Directeur Geral de Recursos Hidricos

Director **Baldé** and his team played a crucial role in the present project because of the great influence hydrological data have on feasibility. He is also in charge of the Fouta Djallon Highlands project (Bissau part) and the Focal point of the OMVG organization. He reported about the actual season, which shows high debits. Because of vandalism in 1985 the level recorder is out of function ever since and no further data could be gathered beyond 1994. There is also no permanent staff to read the gauge meters. When it comes to shared water basins, the hydrology comes under OMVG. The absorption rates of the soils along **Corubal River are** very different. Since we were looking for detailed hydrological data, he referred us to OMVG which should have all the data available.

There was a long discussion with the team about how to get daily gauge data from the old ones used in the COBA study and the newer ones. It is recommended to determine the possible influence of climatic changes in **debit**. While the meeting ended with no success on these critical data, daily gauge measurements could be found with one of the hydrologists the day after and via internet with GDRC.

3.2.2 Seco Bua Baio, Director Geral de Geologia e Minas

Besides the known documents on Geology in the COBA study, he explains and hands over a general study, done by Technoexport, URSS on the

Comentado [L1]: haben wir da details über wie "different" sie sind – Grundsätzlich ja; haben wir. Ist aber für unsere Aufgabe zu detailliert.

geological research for construction material, executed 1979 to 1981 and continued 1983 to 1986. This study, based on more than 200 drillings and other geological research gives a good documentation of the geologic conditions in Guinea Bissau.

3.3 Ministerio de Agricultura

The meeting was held with State Secretary for Food Security, Mme. Nhassé and her team. Engº. Braima Djassi was at the COBA time in the energy ministry and worked with the COBA hydrologist. He informed about an existing environmental report, so far not recognized. There is little interest from agricultural side on the areas along the Corubal River, since there is mainly poor lateritic soil to be found. However, they have heard about some local transfer towards big landowners. There is an interest to transfer water from the river for further use in irrigation systems. As for Geba, they speak of the Sonaco (Carantaba) rapids a few kilometers upstream of our visiting point. However, these small rapids qualify in their eyes most probably for agriculture use but not for energy generation due to the low head and unsteady water regime. A similar situation might be with the intended dam at Campossa (an OMVG project). Engº. Correia sees the two dams in Senegal in a positive way. After the dams were put in place the annual floods have been reduced drastically and enabled cultivation in most of the rice fields in the surrounding area of Bafata (before the dam the water level was too high for cultivation). It is anticipated, that the salt water intrusion is moving upstream, due to the reduced water flow. The overall strategy can be described as selective in contrary to a standard approach of a strategic general plan. Reasons for this approach can be found in the limited number of resources available to the ministry.

3.4 State Secretary for the Environment and Tourism

Meeting was held with Mestre Ernesto Augusto Pereira, the General Director for the Environment. He functions also as operating focal point of GEF. In principal he is supporting the construction of a dam in the Corubal River, as long as the environmental laws are observed. He explained the situation on how to get environmental clearance for such projects and handed over the relative laws. In order of rank, there is the Environmental Base Law (1/2011) and the Law on Environmental Impact (10/2010). Thent here is the Law on Residue Plastic, which is less relevant for dam construction. The next steps that will be taken by the State secretariat are the proclamation of the law on Environmental Crime and the Construction of Houses in humid Zones. For the dam itself there are furthermore the laws on forest and on land reason.

3.5 African Development Bank, Bissau

Up to 2011, there was a team of two experts present in Bissau. Nowadays, only Albino J. Cherno Embaló, Assistant Administrative, remains. The bank has disrupted the cooperation, but there will be a mission from head

quarters coming soon to discuss on a possible partial lift of the sanctions. This would enable to finalize what was ongoing before the disruption. The existing paper on strategy 2012 to 2016 had no energy component. However, such paper needs to be revised and discussed with the new government. Since ADB treats renewable energy as a priority, the new strategy will most likely include renewables in its agenda. As with OMVG, the AfDB is not fully consistent vis-à-vis Bissau. The bank has signed some contracts recently and made other sources of finance available for Bissau.

3.6 UNDP, Bissau

DaudaSau, Conseiller National Spécialiste en Changements Climatiques, describes the actual position. UNDP supports via GEF policy matters and the strategy in reduction of CO2. There are no active projects on electricity generation. However, there are some joint activities with the World bank and other partner, come la Cooperation Suisse. There is continuing support for the ECOWAS white book (mentions a recent work-shop); several capacity buildings in environmental issues. UNDP is interested in energy efficiency, especially in public transport; but work mostly up-stream. He refers to the environmental project on Fouta Djallon Highlands in cooperation with GEF. UNDP is interested in joint projects with ECOWAS/ECREEE.

3.7 European Delegation in Guinea-Bissau

Actually, the EU finances three projects: the "Tese project" (PV – diesel hybrid system) in Bafata area, a PV (solar home system) project in Gabu area and a biomass project. There were a number of even big projects foreseen, but suspended due to the political situation. The same happened with the joint projects under OMVG. They should work now on the preparation of the program of 2014 to 2020 (11th FED) but cannot make the necessary joint priorities without a local governmental partner. In the next years there will be a bridging facility, showing the priorities of: Rural Development (markets, roads, plans,...), Health and work for youngsters. In case there is a lift of the suspension, the EU will most probably step in with a major program under the bridging facility.

Since there is a clear priority in Brussels to support the "SE4ALL" program, energy might play a key role in any new cooperation. However, they see major problems in the electricity sector of Bissau if there is no solution on tariffs, the technical and the commercial losses; the utility as such needs full reorganisation. It was also mentioned, that Bissau could have a small window via regional programs and such regional budget for ECOWAS will be discussed, beginning October in Abidjan.

3.8 Other Financing Institutions

The Director General, Ministry of Energy tried to facilitate a visit with other financing institutions by the project team. Institutions such as World bank and

Comentado [L2]: Um welche geringe Change handelt es sich? – Gute Frage; Für uns aber nicht interessant – wichtig für nachverfolgung durch ECREEE). Mail info ist erfolgt

BOAD did not respond to this request. Therefore no meetings could be held with these institutions.

3.9 Cuntabane; Village Chef: Alfa Tall and Advisers

Responsible of the villages along Corubal left bank, including Madina-Dongo, Gobuje and Giledje (has been said so also by the chef of Sintcham Sambel). Asked about the dam he answered: "This is a story like a dream that somebody will construct a dam here. We have heard about the dam long time ago. The government did not do anything, even did not give work to the young people". He mentioned an example from Senegal, there is electricity even in small villages along the border. Without electricity there is less economic development and they remain in an underdeveloped situation. Furthermore he said: "We have been forgotten by the Government".

Summarizing the citizens will most likely accept relocation in case of a dam construction since there is a job perspective for the younger generation. He pointed out that the older generation will most likely not profit from its construction except for the availability of electricity.

3.10 Sintcham-Sambel; Village Chef: Aladje Suleimané Baldé; Site of Saltinho HPP

When asked about the water level and his level of knowledge about the planed dam he answered: "The first studies showed that they have to leave the village. Afterwards there was more explication on the future water level. During the second study we have seen the design and got an explication how the system of the gates will operate." Mr. Balde was send to Europe and shown different dams, a technician from Portugal explained further details. In case of a vote pro or against the dam he thinks it still will be built to a maximum of 10% against votes. When asked about the main challenges for his village he responded: "My focus is currently on the dam, agriculture, education and problems with drinking water. The only remaining well we have has problems with iron oxide, so we need to go to the river."

3.11 TESE -Development Association, Lisbon, Joao Arsenio, Project Technician

TESE a Portuguese Non-Governmental Development Organization with its international unit of "Engineers Without Borders" is working under ACP-EU Energy Facility contract N°2011/231-830 Bambadinca, Sta. Claro – Community Program for Access to Renewable Energy (EU Energy Facility 75 % and Portuguese Cooperation Agency 25 % - total 2.141 million EUR). Expected beneficiaries of about 1000 households, 84 existing micro-enterprises and 16 institutions will get access to a micro grid, based on a PV-diesel hybrid Power Plant system.

The resident manager Joao Arsenio explained the plant management as being under a tri-party arrangement, the local grid owner, the Bafata direction of energy and TESE. Once fully installed, the plant and related

system will function the first year under contracted maintenance with TESE. Given the local situation, TESE is critical towards bigger grids, like the one with WAPP. He gives priority to small and decentralized grids. He faces serious problems with non-existing regulations and rules. They could use the old, mostly cannibalized 30 kV line, but there are no specifications on future voltage levels. There is no legal document what series of voltage levels the government will follow (proposals are with 10, 33, 63, (161) and 225 kV). There is a lack on appropriate technical norms, like on protection. Tese focuses on a program based approach rather than on a project approach. Arsenio explained the problems with the old tariff scheme and their efforts to reach agreement for an appropriate electricity price. Tese has prepared a holistic cost approach, based on time and cost for replacement, the related team cost and material costs. All activities are handled in full agreement with the ministry. Guidance on various types and tariffs is based on existing small PV installations of ACDB and their 12 years of experience with about 3 kW_p. The discussion is still ongoing how to overcome differences in willingness to pay and ability to pay; as well as in pre-financial planning or pre-paid system approach.

Finally, he assured that even under the actual problems between EU and government there was never any problem in financing of the project.

4 Field Trip

Remark: Due to the fact that Corubal river drains into the Rio Geba estuary and not directly into the sea, the Corubal is often seen only as a tributary from the Geba river (although the Corubal shows higher discharge than the Geba). Therefore, gauge stations or projects along Corubal river quite often have an indication of Geba river. In this report, they are handled like two different river systems.

4.1 Corubal River

4.1.1 Generals

The Corubal (named Koliba in Guinea) drains a total area of about 24 000 km², out of which 17 500 (or 72.7 %) are in Guinea and only 6 500 (or 27 %) are situated in Guinea-Bissau. The gauge at Saltinho (amont)³ shows a high but very irregular discharge. While the mean monthly discharge observed in dry season (May - minimum) decreases towards 8 m³/sec, the mean for rainy season (maximum in September) reaches some 1 160 m³/sec. During the reported observation period from 1977 to 1994, the minimum monthly discharge reached 5.4 m³/ sec, while the maximum was 1 600 m³/sec.

4.1.2 Salthino Site

Given the clear instructions and finally good cooperation with the two mainly involved ministries (energy and natural resources), quite a good

³GHAASBasin437 Basin, Station: Saltinhoamont, UNH/GRDC

amount of (mainly historic) information could be gathered. It is anticipated; that the available reports will considerable reduce the content for review of Saltinho HPP's feasibility. A list of related documents and reports can be found in Annex B.

The old gauge downstream of the bridge was visited on September 21, at 16h and showed a water level of about 3.50 m. From the five scales only the last one (gauge level 4 to 5 m) remains. Due to the good accessibility close to Sintcham Sambel and the availability of local hydrologists, it is strongly recommended, to rehabilitate the former gauge and enable daily readings from the renewed scales. Since such readings could be directly related to older data, much better hydrology data – necessary for a good feasibility (definition of generation and annual capacity) – are achievable at very low cost. Such works need to be started in the next dry season, enabling the future consultant to use the data during his work. The readings shouldn't be stopped after the consultant works but continued to allow for eventual adaptation once the construction season starts. GPS-Data: N 11°40'46.3099" W14°38'58.94.



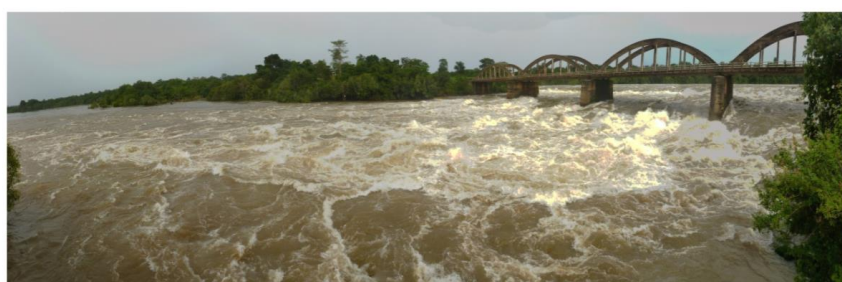
In order to review and modernize the available studies to be developed to bankable feasibility stages as well as financial structuring of the project, fund mobilization and preparation of tender documents a number of work packages need to be developed.



Saltinho site, upstream of road bridge, on Sept. 21, 2013



Saltinho site, road bridge and towards downstream, on Sept. 21, 2013



Given the complex situation for construction of a dam in a sharp bend of about 90°, it is highly advised to **implement a physical model** which could be used to optimize the location of the dam itself, but also for optimal flow conditions towards the power house as well as the gates during flood conditions. The available hydrology data will be used to define the necessary work on water resources. So far, the available studies report on five different maximum reservoir levels. Given the living conditions of many peoples in Sintcham-Sambel and Saltinho as well as the other villages, especially on left bank side, around Madina Dongo and Gobije or CheChe the two higher levels of 43 and 49 m can be ruled out due to their expected high impact. But between the other mentioned **levels of 36, 37 and 39 m, a serious optimization** needs to be conducted. Such optimization should target at one side at maximum annual generation (not capacity) and on the other side on minimal impact on environmental and socio-economic issues. Although, Saltinho is considered as a regional OMVG project, it is advised that the backwater reach does not enter the bi-national area at the Rapidos de Quibaba, to avoid possible complicated juridical procedures for

the dam. To allow for minimal additional environmental works, the ADB study on these issues, performed in 1992/94 needs to be found. So far no impact was mentioned from local side concerning the **planned (instituted)** Dulombi – Boe National Park on both side of the river.

Comentado [L3]: Situation to be defined by RAUL

Based on the above proposed works, the **old design should be modernized**. The design of the early eighties follows more a high head dam than a modern run-of-the river concept, the construction volume looks very high and the power house needs to be adapted towards modern turbine design. Therefore, once optimal situation and reservoir level is defined, a low-head design consultant has to revise the complete design works, including reduced bill of quantities. The available specifications might be of use in those areas, where local conditions have been nicely foreseen. Many others, most technical issues are too old and need total revision since they are fully outdated after 30+ years.

Besides the main elements of the proposed Saltinho dam it is advised to also include several additional measures. The review of Societe Generale pour l'Industrie included already 1987 the additional provision of a **fish ladder**(nowadays Organismenwanderhilfe).

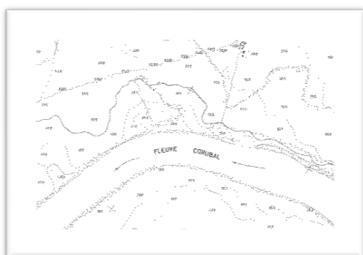
Comentado [L4]: If no good translation found – erase)

The specification for the civil contractor also contains instructions for the construction camp being mandatory to establish a functioning construction site. The camp specifications (Sintcham-Sambel or Saltinho site) should include **the handing-over of houses for the residents in a mid-term to long-term perspective** (after construction). Focus will lie on the compensation of families directly or indirectly affected by the construction works or the dam itself. The local specifica and needs should be integrated in close cooperation with the local village heads.

Similarly, general camp facilities such as the necessary health post and education facilities are to be integrated in future village planning. The other part of the camp should be transferred towards the operating company and allow for adequate future staff housing and offices. Only parts of the camp are not dedicated for long-term use after construction and thereby should be built for temporarily use. It is further advised, that drinking water supply and solution for sanitary waters in Sintcham-Sambel play an adequate role in the planning and design of general project outline.

4.1.3 Reservoir Area

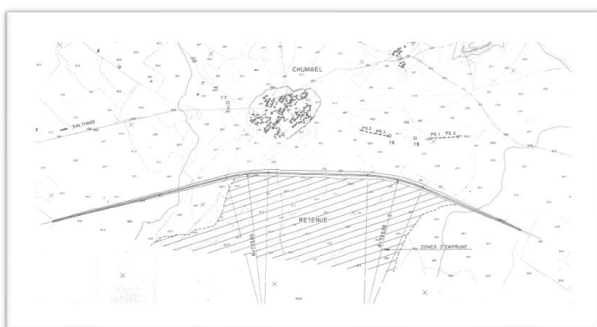
- o Sinta Ncanta village, right river bank at: N 11°39'4.3" W 14°39'48.6"



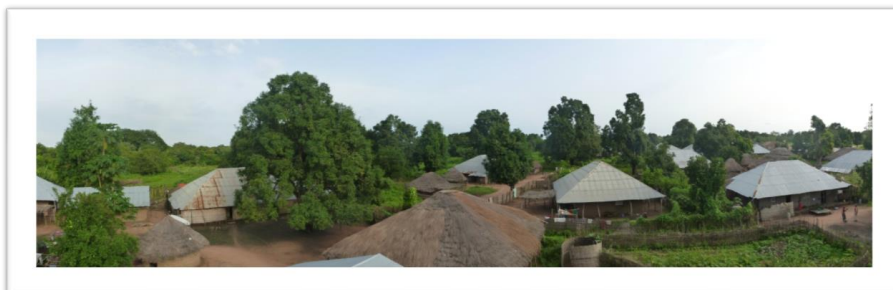
cultivated terrasses on right bank,
but flooded during extreme floods



- o Chumael village, right river bank at: N 11°40'46.3" W 14°38'58.9"



COBA planned a protection dike to avoid flooding several villages in this area and loose water
towards Rio Geba in case of higher planned reservoir levels



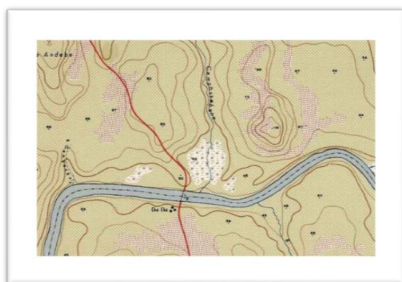
View from water tower towards Rio Corubal

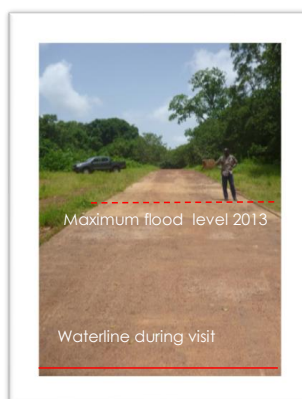
- o Opposite CheChe village,
right river bank at: N 11°55'55.7" W 14°12'41.2"



Site of CheChe ferry boat, right bank

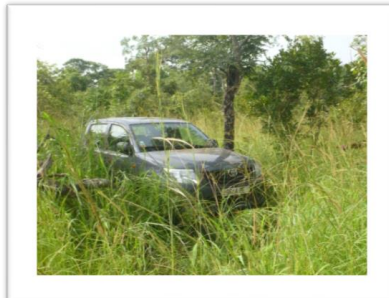
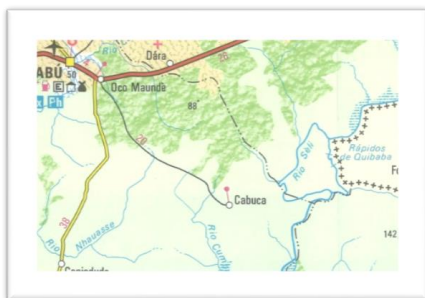
- o Boat trip around CheChe, total distance about 2 kilometers upstream





Indicating highest water level at ferry pier during rainy season 2013

- o From Cabuca village towards right river bank near bi-national river stretch



Finally no access achievable due to high water level on the ground

The TORs for the intended consultant review should include clear integration of all environmental issues along both river banks up from Saltinho towards the end of the backwater area; especially deal with issues coming from integrating the future reservoir into the developing Dulombi - Boe National Park. In order to avoid/decrease GHG problems in flooded areas, the consultant should **develop a clearance scheme** similar to the one used for construction of Bagré dam in Burkina Faso. In this case, local people should be given rights for manageable clearance claims. The cut wood is to be

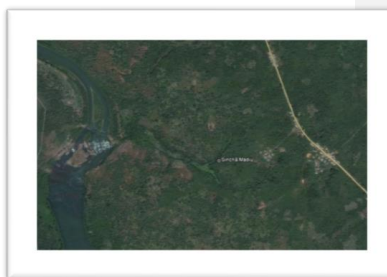
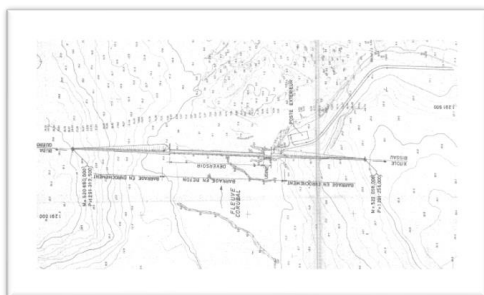
carbonised either decentralised by the families/village or in central units and finally the charcoal sold on the market (participation of riverine population with local financial benefits is strongly preferred over a centralised commercial solution).

4.1.4 Cussilinta Site

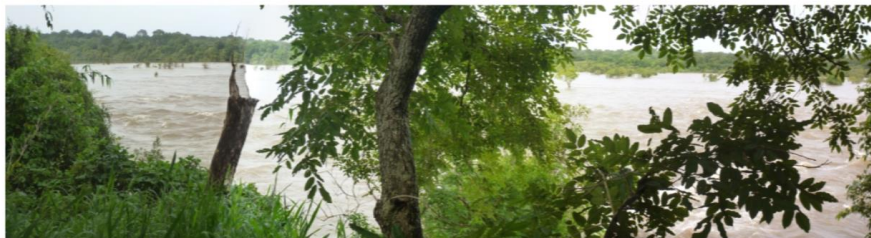


Site is only 3 200 m from tarmac road, branch at Cambessa.....

The COBA study includes only preliminary ideas about the Cussilinta dam. However, there is a photo grammety at M 1:5 000 available. In addition to that, there is quite detailed geology information available (Technoexport 1982). Since there is no major tributary between Saltinho and Cussilinta, the hydrology (including the foreseen operating rules) of Saltinho HPP, once established, are a full base for optimization and hydrological frame for a dam at Cussilinta. Since the COBA study is available at pre-feasibility level only, the dam design has to be detailed and optimized (exact location, type of dam, type of flood gates, power house design).



Cusselinta site, right bank, just upstream of Rio Cussol, view into SW, on Sept. 21, 2013



Cusselinta site, right bank, just upstream dam site, view into South, on Sept. 21, 2013

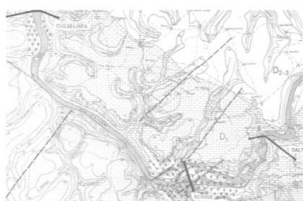


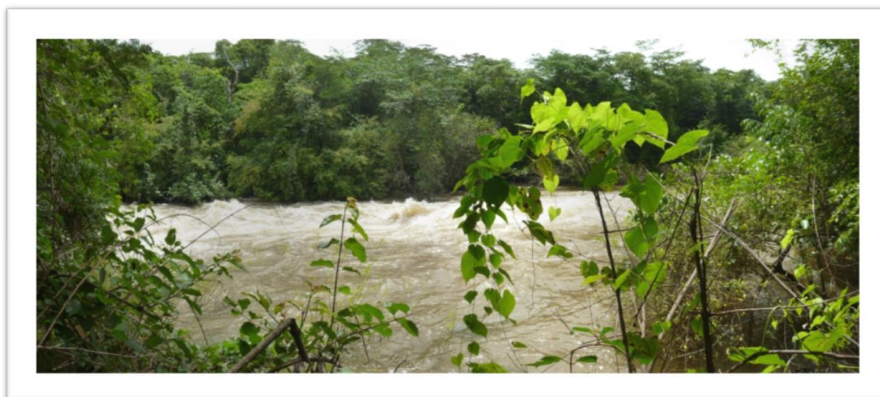
Impressions from Cussilinta©Jose A. Sousa, February 2012

4.1.5 Sourire Site

Between Saltinho and Cusselinta site, another rapid with outcropping rocks, would be suitable for a dam. A preliminary survey made by COBA revealed the general feasibility. However, and given the available sites at Cusselinta and Saltinho, the Surire site is less attractive for the overall development of Corubal river and had already been ruled out by COBA in 1982 also.

The Surire island is a local recreation area during dry season and will certainly be flooded, when Cussilinta dam will be constructed.





Branch of Corubal river at Surire site, close to C1, on Sept. 21, 2013; 12h

4.1.6 Generals of the Corubal HPP Scheme

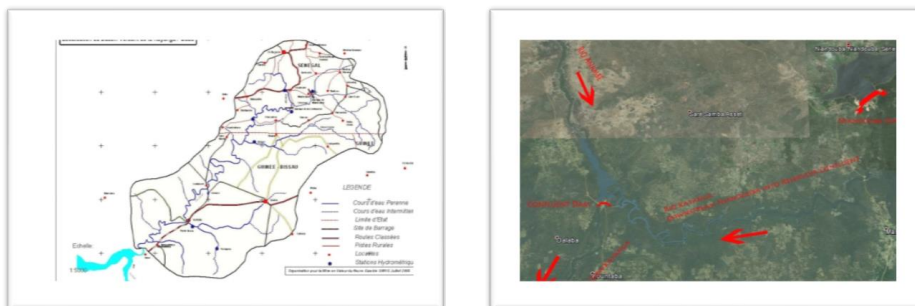
As for the Corubal, the dam sites of Cussilinta and Saltinho are well chosen to cover the possible generation from the lower reaches. Only the reservoir level and their operation rules need to be optimised for best integration at maximum generation. Not much can be said about the stretch, starting at the joint border with Guinea Conakry. Given the general geology and river type, it might be feasible that the Corubal/Koliba allows for more dams further upstream; even along the bi-national border and therefore of interest for Guinea Bissau. So far OMVG has retained a candidate detention dam at FelloSounga and the Gaoual site, both on the Tominé River in Guinea. The Tominé and the Komba Rivers join to form the Koliba in Guinea.

Comentado [L5]: Additional text

So far no hydropower exists in Guinea Bissau. In order to facilitate start-up and integration of a “new” technology, it is advised to install a separate Corubal Hydropower Development Company, being transferred later into the operation company. This allows not only any financial construction (including foreign direct investment, if appropriate), but also twinning up with Cussilinta HPP later on and to achieve possible synergies. For both sites it is recommended to use the same type of machinery this will not only be simpler in operation for the staff, but also cheaper in capacity building, maintenance, spares and in investment. Initiating the two sites as a scheme and not as two separate projects asks for good sequenced planning but enables also many benefits. If well planned from the very beginning, the capacities on consultant and on contractor side could smoothly fade out from one site and start the next – this allows for serious reduction in overall investment cost without stressing the construction market in Bissau. In case both dams would be treated separately and building time overlaps, an higher inflation rate and market stress can be expected. The foreseen procurement documents should take this sequenced investment into full consideration; special attention should be given to the consultancy work on developing the fully integrated design and construction schedule.

4.2 Geba River

4.2.1 Generals



The Geba/Kayanga river basin covers some 12 800 km², out of which 67.7 % are in Guinea Bissau (31.9 % in Senegal and 0.4 % in Guinea). In the upper reaches and on Senegal soil, two irrigation dams were constructed – the Confluent Dam (1984) on the Anambé (volume 59 million m³) and the Niandouba Dam (1994, volume 85 million m³) on the Kayangariver (name of Gebaupstream of his confluent with RioBidigor)⁴. The operating level of Confluent ranges between levels 20 and 22.3 m IGN and the Niandouba reservoir ranges between the levels of 26 and 32 m IGN. The release of Confluent dam towards the border with G-Bissau is mentioned for being in the order of 3 m³/sec. The flow entering Guinea-Bissau could be well defined via the gauge at the Wassadoubridge, only a few kilometres before the borderline on Senegal side (a key point for any possible water sharing agreements). Future development plans discuss about additional dams, such as the Vélingara Pakane dam, upstream of Niandouba.

Given the construction head of 11m above soil, the water level downstream Confluent dam ranges therefore at about 10 m a.s.l.– these two facts are the basis for any possible generation on the Geba in Guinea Bissau. The discharge (without additional contribution from tributaries in G-Bissau, like Rio Bidigor) ranges about 3 m³/sec and the total available head on the 140 km stretch between the border with Senegal and the sea is about 10 meters.

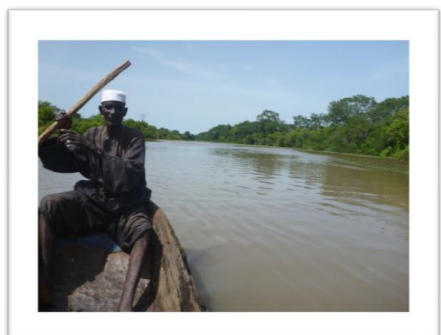
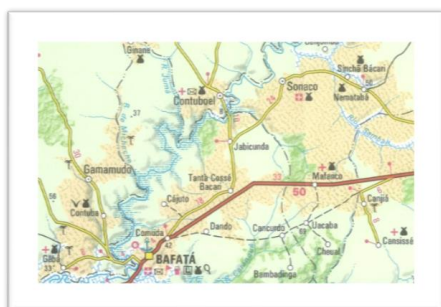
The Geba drains/irrigates paddy fields in the populated Bafata region. As per Ministry of Agriculture, many of them could be cultivated only after the Confluent dam reduced the flood level. On the other side, the reduction of river flow increased the tidal influence and thereby salt water intrusion. Already the Portuguese lamented the tidal influence in Bafata, which prevented them from establishing a duration curve on Geba discharges.

Also the main river (Geba) is well reflected in the PAGIRE-study. However, there is a main difference in available heads on the Geba between PAGIRE and IDEV-ic Study under IUCN. In PAGIRE, Studi consultants give the altitude

⁴ UICN and IIED, État des lieux autour des barrages de Niandouba et du Confluent au Sénégal, October 2010

at confluent dam as 25 m leading down towards Carantaba (163 km) and reaching there a 16 m altitude. This leaves 7m of head between Carantaba and Contoubel, the zone of rapids of Sonaco. Finally, there is still some 9 m altitude left for the remaining 153 km from Contuboeil to the river mouth. But when looking into the data from IDEV-ic, the level at Confluent dam is operated at 22.3 m; leading to a river level downstream at about 10 m a.s.l. The Department of Water Resources has been asked for a longitudinal section of Geba which would clarify these differences.

4.2.2 Sonaco



At the visited ferry boat landing on the Geba at Sonaco (GPS-Data N 12°24'5.62"W 14°29'30.21") the river showed clear indications of a very slow flowing river (like sandy/silty islands, floating macrophytes) even in full rainy season. The (historical) measured annual peak flow (at Sonaco gauge) varied between 60 m³/sec (in 1949/50) and 320 m³/sec (in 1957/58); while the low flow tends towards 0 m³/sec before rainy season.

A gauge was identified on the road bridge close to Contuboel (GPS-data: N 12°20'55.7", W 14°32'56.2", see picture below). On Sept. 23, at 12.30h the level showed 3.40m. The level recorder is missing.

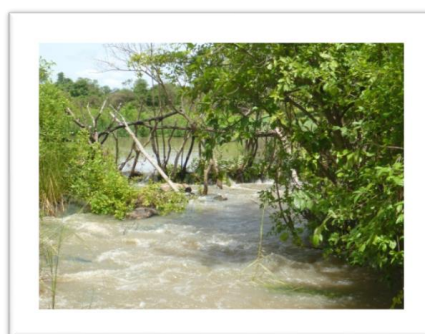
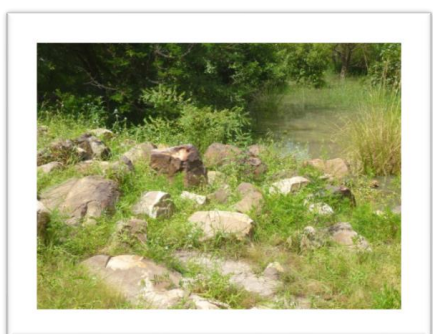
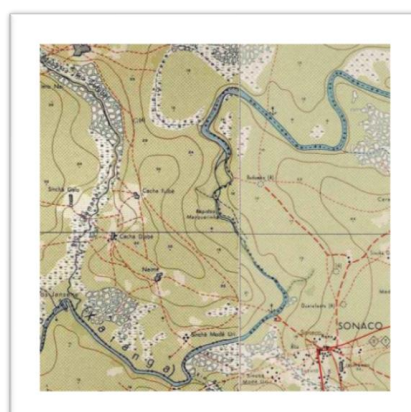


4.2.3 RapidosJansene

The riverine areas along Geba river are cultivated for rice. Especially the flats along the tributaries of Rio Chancana and Rio Pumaná on right bank of Geba are well cultivated. The mentioned Rapidos Jansene, are situated between the two above mentioned tributaries and therefore nearly not accessible during rainy season and could be found after several attempts only. When finally reaching (near) the said rapids, local farmers reported turbulences in the river, but to be seen (and heard) during dry season only. The open and flat area is not in favour for a river dam there.



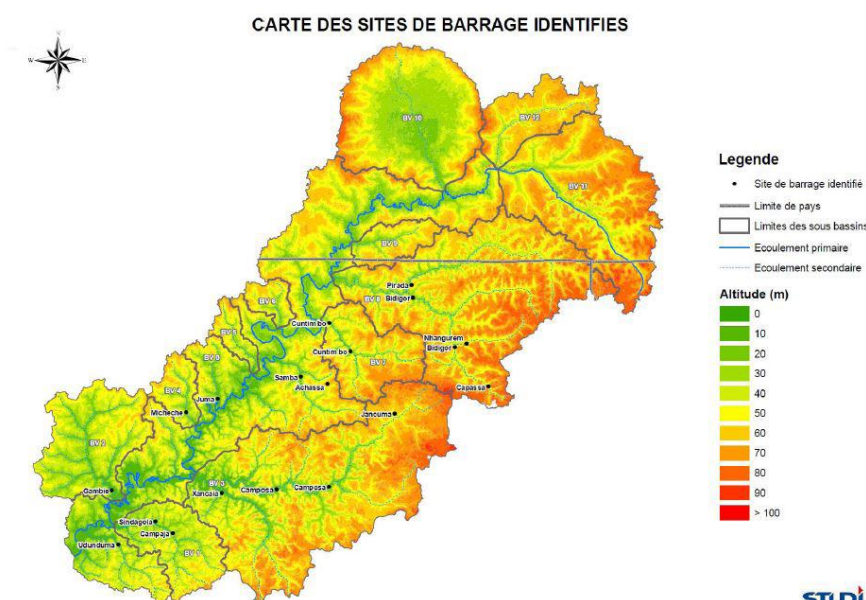
4.2.4 RapidosManquerina



Upstream and downstream view of temporary dam for fishery at Manquerina

Orientation in the field not only needed strong assistance by local farmers, but led also to confusing description of sites; like with the Rapidos Manquerina. Finally and based on GPS data, the site could be defined and shown as being a branch of Geba in the Manquerino rapids and not a nearby tributary; such as the Rio Pumaná (some locals). Obviously, there is some head available in this rocky reach of Geba, forming a nice valley for a river dam. However, there is not enough geodetic information available, to indicate possible feasibility for electricity generation. Any possible raise in water level needs to be harmonised with existing paddy fields upstream and east of Canquenhe.

4.2.5 Sites of PAGIRE Study⁵



Under the OMVG, several irrigation schemes with river dams mostly on left side tributaries were studied at feasibility level. No further details could be found during the mission on how possible generation capacity or water balance between generation irrigation and water losses (evaporation, floods or filtration) were calculated. In order to investigate on possible sites for “energy production for productive use” the available studies under OMVG will be checked for feasible sites. It is emphasized, that the mentioned dams are under agricultural priority; the dams will be constructed mainly for agricultural use and secondly for energy use. Only in specific

⁵ As per : Bureau d’études STUDI International l’élaboration de l’étude GIRE du bassin versant du fleuve Kayanga/Gêba et des études de faisabilité et d’avant projet détaillé (APD) d’ouvrages et d’aménagements hydro agricoles en Guinée Bissau sous contrat du secrétariat exécutif de l’OMVG

International Hydropower Specialist for Guinea Bissau –Renewal/update of feasibility studies on small hydro sites from the 80es
and development of a technical paper on the status and perspectives of the hydro power sector in Guinea Bissau –Mission
Report –Rudolf Huepfl and Julio Antonio Raul

cases the integration of a small generation unit might be feasible; to be
handled as a piggy-packed initiative.

5 Assessment of other hydro potential

Given the poor available hydrological data on major rivers (Geba, Corubal)
in Guinea-Bissau, even less is known on other river basins such as the Rio
Cacheu, the Rio Grande de Buba, the Rio Cumbija, Rio Cacine or the Rio
Tombali. However, they have one general in common: a long stretch of tidal
influence and salt water intrusion into the basin. Based on indicated high
tidal level differences and possible high flow velocities, there is good chance
for feasible marine generation, either by typical use of tidal reservoirs or the
use of kinetic forces. The relative small river basins might probably not qualify
for small hydro development out of river flow from drainage. However,


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5 ANNEX A – Stakeholder visited

Organisation	Name	Function	Contact detail
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	LambertoSoaresCama ra	Director General de Energia	
	BiabéSigá	Directeur de Energia	biabesiga@yahoo.com.br
	Julio Antonio Raul	Consultant National GEF UNIDO	antoniobolo2005@gmail.com
Ministerio dos RecursosNaturais	InussaBaldé	Directeur General de RecursosHydricos	
	AlvarengaCrisosfoleo	Director de Serviços da Gestão dos Recursos Hídricos	
	Francisco Vasconselho	Chefe de repartição de Planificação Hidraulica	00245 593 6037
	Paulino Sousa Azinhaga	Chefe do Departamento da Hidrologia	
	Engº. Florinda Fonseca	QuadroTécnico da DGRH	
	Seco Bua Baio	Directeur General de Geologia e Minas	Secobuabaio1@yahoo.com.br
Secretariat d'Etat de l'Environnement et Tourisme	Ernesto Augusto Pereira, MSc.	Directeur General de l'Environnement	Pereiraernesto631@yahoo.com.br
Ministrio de Agricultura	BilonyNhama M.Nhassé	Secretaria de Estado, da Segurança Alimentar	
	Raul BraimaDjassi	Rural Engineer, hydrologue	brdjassi@yahoo.com.br
	Aguinaldo Mendes Correia	Chefe de servico de Hydraulico	
	Raul Sanha	Chefe do Gabinete de SESA	
	Arnaldo Teodoro Fernandes	AssessorAdmin. et Financa	

European Union, Delegation in Guinea-Bissau	Madeleine Onclin	Chefe de sector – Infra- estrutura e programas Temáticos	Madeleine.onclin@ec.europa.eu
	Pauline Gibourdel	for Luis Torres	Pauline.gibourdel@ec.europa.eu
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United Nations – Development Programme (UNDP)	DaudaSau	Conseiller National Specialiste en Changements Climatiques	Dauda.sau@undp.org
TESE Associacao para o Desenvolvimento	Joao Arsenio	Technico de Projecto	j.arsenio@tese.org.pt

6 ANNEX B – Available Documents and Reports

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- o Lei nº. 5-A/2011; Lei Quadro das Areas Protegidas
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7 ANNEX C– Equipment used

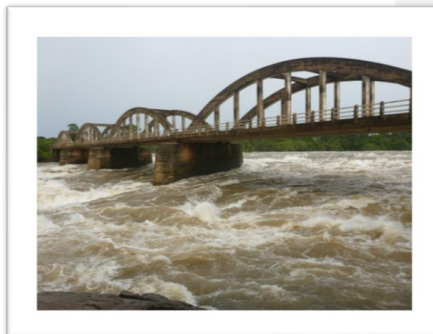
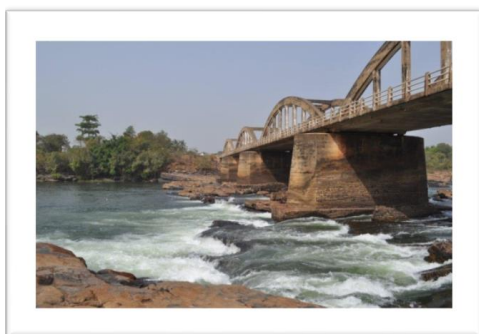
Location (GPS) and necessary photo documentation was performed by:

Device	Model	Function	Output
Panasonic, Lumix	DMC-FT3	GPS and photo	Documentation

8 ANNEX D – Sites visited

The following documentation is in addition to those photos, already inserted in the report above to allow for a more detailed look at sites of interest for possible hydropower generation.

Salthino area



Comparison: low flow as seen on Jan. 2012 @M.Lugmayr and rainy season on Sept. 21, 2013



View from right bank towards SintchamSambel, upstream Saltinho rapids, Sept.20. 2013