



Inga : a necessary mega-project that still needs to mature

By François Misser

Journalist and contributor to the yearbooks published by the Expertise Center for Central Africa CREAC, which depends from the Royal Museum for Central Africa, from 2011 to 2016. Author of a monography entitled « La Saga d’Inga » published by L’Harmattan and the Royal Museum in 2013.

The largest single hydropower site in the World

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- Congo has been endowed with the largest hydropower sit in the world with a total potential of 40 to 44 GW, which accounts for about 40 percent of the country's huge hydroelectric potential estimated at 100GW
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- This huge potential has been explored since 1885, namely by a Belgian geographer called Alphonse Jules Wauters who was already imagining that the Inga falls could generate enough power for the neighbouring regions and countries.
- I would like also to pay tribute to Pierre Geulette, member of the Royal Academy of Colonial Sciences who published a thesis on the subject called « Considérations sur l'aménagement hydroélectrique du fleuve Congo à Inga » in 1955.
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- So far, only a tiny share of the potential is being exploited with the construction of Inga 1 (351 MW) and Inga 2 (1,424 MW). Their combined generation power only represents 4.4 percent of the site potential.
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- Inga 1 and Inga 2 were completed in 1972 and in 1982 respectively.
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CARACTÉRISTIQUES DU SITE D'INGA - RAPPEL



Fleuve Congo:

- 40 000 m³/s en moyenne
- Crue exceptionnelle :
~ 95 000 m³/s

Puissance Hydroélectrique:

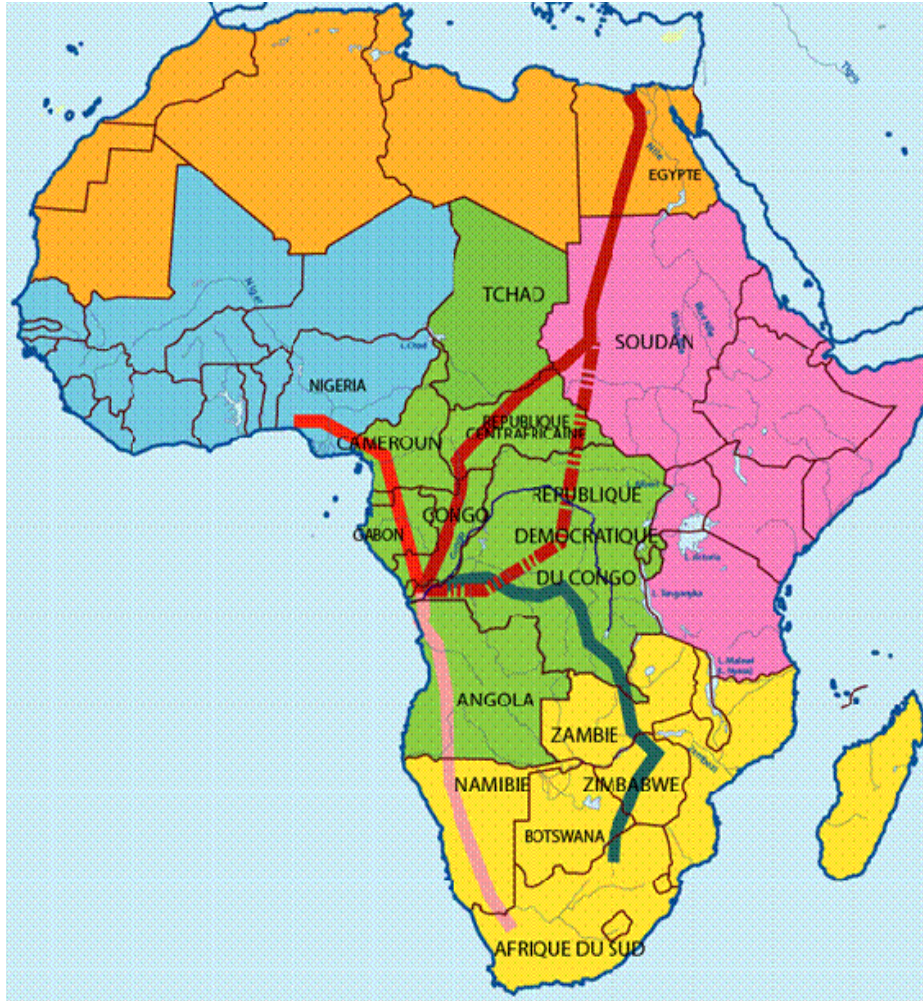
- **Inga I:** 351 MW (existant)
- **Inga II:** 1424 MW (existant)
- **Inga III:** ~ 3500 MW
(en projet)
- **Grand Inga** ~ 39 000 MW
(en projet)

- **The African Energy highways**

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- A number of engineers have been making plans on the development of the project and of its associated transmission lines. In 1993 and 1997, Electricité de France International and Lahmeyer, completed a prefeasibility study financed by the African Development Bank (AfDB) on the Energy Highways from Inga, to Egypt, South Africa and Nigeria. Clearly, these engineers were seeing Inga as the gordian knot of Africa's energy development

PROJETS D'INTERCONNEXION AU SITE D'INGA - RAPPEL



- **Ligne RDC – Égypte:** 5300 km
- **Ligne RDC – Nigéria:** 1400 km
- **Ligne RDC – Zambie – Afrique du Sud:** 3 676 km (dont une partie existante à renforcer)
- **Ligne RDC – Angola -Namibie – Afrique du Sud:** 2 734 km
- **Ligne vers l'Afrique de l'Est**

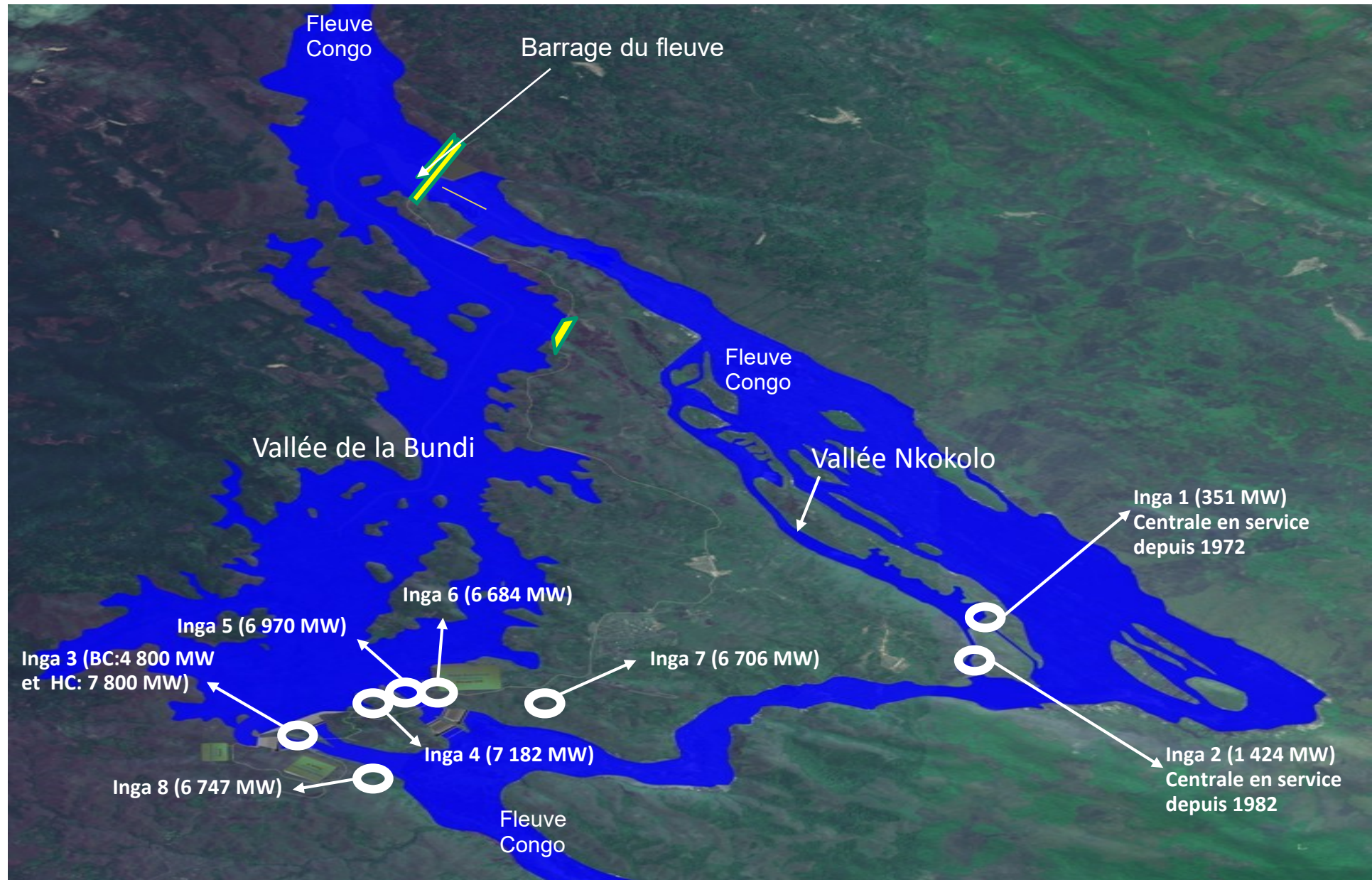
Inga 3 lower fall, the first step towards Grand Inga

- Engineers and planners began again to think about the future development of Inga after the two Congolese wars of 1996-1997 and 1998-2003.
- The idea was to build a third dam, much larger one on a valley, the Mbundi valley which runs parallel to the main course of the river and the adjacent Nkokolo valley where the existing dams are located. Plans were to divert the largest part of the river flow into the Mbundi valley through an in-take canal and bring water to the turbines at the junction with the original riverbed, to generate something between 3,000 MW and 4,000 MW.
- In 2003, a new entity was created under the auspices of the Southern African Development Community (SADC), the Western Corridor. The plan was to bring power from a third dam on the River Congo, all the way down to South Africa via Angola and Namibia with a hook to Botswana. But the project did not materialize, mainly because the DRC which hosts the site Inga were only given a twenty percent stake in the company in charge of the project.
- A new study on this new project called Inga 3 Lower fall was launched in 2008 by the AfDB and carried out by EDF and the Canadian consulting firm RSW, now absorbed by AECOM. The study was concluded in 2013 and Inga 3 was defined as the first phase of the construction of Great Inga.

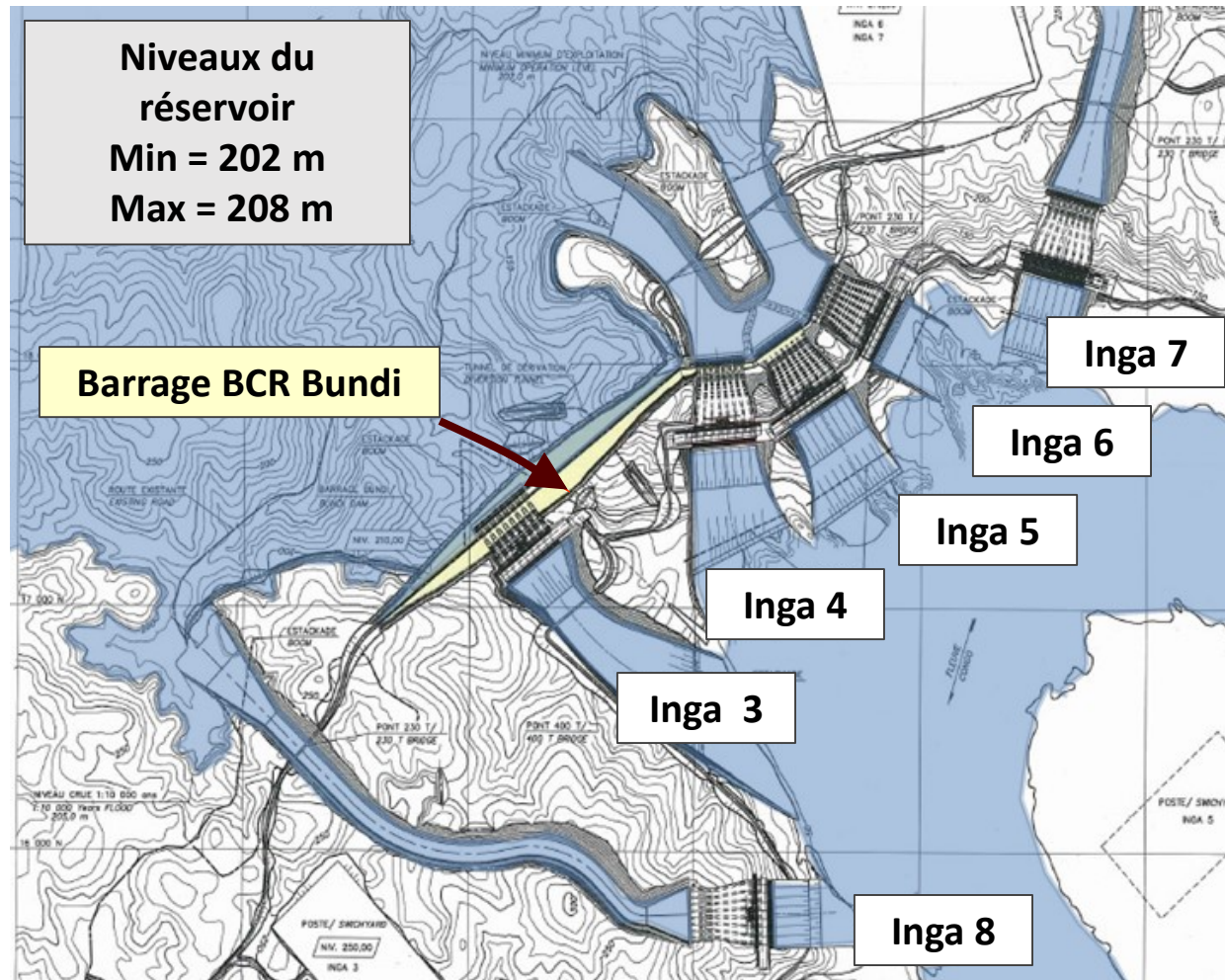
- **Inga 3 as the first phase of Grand Inga**

- Cumulated potential
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|---------|--------------------|----------|-----------|
| Phase 1 | Inga 3 Lower Fall | 4,755 MW | 4,755 MW |
| Phase 2 | Inga 3 Higher Fall | 3,030 MW | 7,785 MW |
| Phase 3 | Inga 4 | 7,180 MW | 14,965 MW |
| Phase 4 | Inga 5 | 6,970 MW | 21,935 MW |
| Phase 5 | Inga 6 | 6,680 MW | 28,615 MW |
| Phase 6 | Inga 7 | 6,700 MW | 35,315 MW |
| Phase 7 | Inga 8 | 6,740 MW | 42,055 MW |

REPUBLIQUE DEMOCRATIQUE DU CONGO
MINISTERE DES RESSOURCES HYDRAULIQUES ET ELECTRICITE



Développement phasé de Grand Inga : Final



Grand Inga – configuration finale

6 centrales
51 groupes
Puissance totale ? 42 000 MW
Energie annuelle ? 340 TWh/an

The Great Inga International Treaty

In 2013, the DRC and South Africa signed an international treaty for the development of Inga, which included a power sharing agreement.

The main off-taker is ESKOM (South Africa) :	2,500 MW
Katanga province and the mining industry :	1,300 MW
To the national utility SNEL :	1,000 MW

Total cost was then estimated at \$ around 11 billion by the World Bank including the transmission lines These a

SAPP transmission lines 2.5 billion

Intake canal and dam 2-3 billion

The bill for Inga 3 Lowe Fall could reach \$ 14 billion including financial costs

Government decides to double Inga's capacity

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- The scale of the project however has been subject to changes recently. In July 2017, the Agency for the Development of Inga (ADPI) has announced that the capacity of Inga 3 would be scaled up to 10,000 MW or 12,000 MW, more than the double of the initial projected capacity of 4,00 MW.
- ADPI's director, Bruno Kapandji also announced that the two consortia which bided for Inga 3 would merge and submit a common offer.
- Those are respectively
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- A Chinese-led consortium called « Groupement Chine d'Inga » which includes
- Three Gorges Corporation, Sinohydro, the State Grid International Corporation, the Chanjiang Survey Planning Design and Recherche Corporation and the Dongfang Electric Corporation
- A Spanish-led consortium called « Groupement proInga » which includes :
- Actividades de Construcción y Servicios (ACS), Eurofinsa, AEE Power, Andritz Hydro of Germany, Andrade Gutierrez Engenharia SA of Brazil and... the China National Electric Engineering Corporation (CNEEC)
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- Whatever the developer the Chinese are on board
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- At the same time, the ADPI announced that the Inga 3 project would only be finalised by 2024-2025 the soonest, four years later than expected.
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• < **The Inga project necessary for Africa's economic future and the global environment**

The Inga project has been described by the International Energy Agency executive director Fatih Birol as « the pearl of all projects »

DRC's hydropower can be a game changer for the continent

1 Inga is indeed a competitive project

According to the World Bank study Inga offers the world's lowest production cost with approximately 3 cents of dollars per kWh

Thereby it provides Congo with a comparative advantage to attract investments and industries which could help to transform its huge natural resources

2 Inga can render huge environmental services

Provided necessary investments are made to develop distribution networks and the use of electric cooking devices it can offer an alternative to charcoal, the main cause of deforestation and CO2 emissions in Central Africa.

It can also help Southern Africa to increase the share of renewable energy in its energy mix and help substitute some of the generation capacity of the environment damaging coal thermal plants

A fantastic potential that should not remain a potential : but many hurdles on the implementation path

- The implementation of the Inga project however is being delayed.
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- This is partly owed to the gigantic size of the project which needs to pool a number of financial resources. There is a need to harmonize strategies between the different stakeholders. At the same time, there are undeniably governance problems. The decision by the World bank to pull out from the project in 2016 is related to the Congolese government decision to launch tenders for the selection of the developer before the Bank's funded studies were finalised. Another problem is that the agency that has to manage the entire project is not under the government's supervision but directly under the president office's responsibility.
- **Geological problems**
- Such reservations may be justified. Indeed, the World Bank technical and financial studies seem justified. In 1955, Pierre Geulette, member of the Royal Academy of Colonial Sciences, raised the problem of the stability of the rocks of the Bundi Valley where the Inga 3 and the Grand Inga dams are to be built. Other testimonies including that of hydrology engineers confirm the nature of geological problems such as the porosity of the rocks, which is already noticed at the existing Inga 1 and Inga 2 dams.
- An additional problem is that during the construction works of the intake canal that will divert the main flow of the Congo River into the Bundi Valley, the existing Inga 1 and Inga 2 hydropower stations will probably stop operating at least a few days or a few weeks. That still has to be addressed
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The Cost issue : who's gonna pay and how ?

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- The considerable cost of the Grand Inga project is a serious issue. Especially if one considers that the figure of \$ 14 billion for Inga 3 Basse chute (Lower Fall) is probably conservative.

Indeed, a number of factors should be taken into account including a 10 percent power loss for the transmission lines and the need to apply a 0.855 factor to calculate the available potential. Yet, this potential only corresponds to the 40GW during four years per annum between october and january. Return on investment has to be calculated thus taking this factor into account.

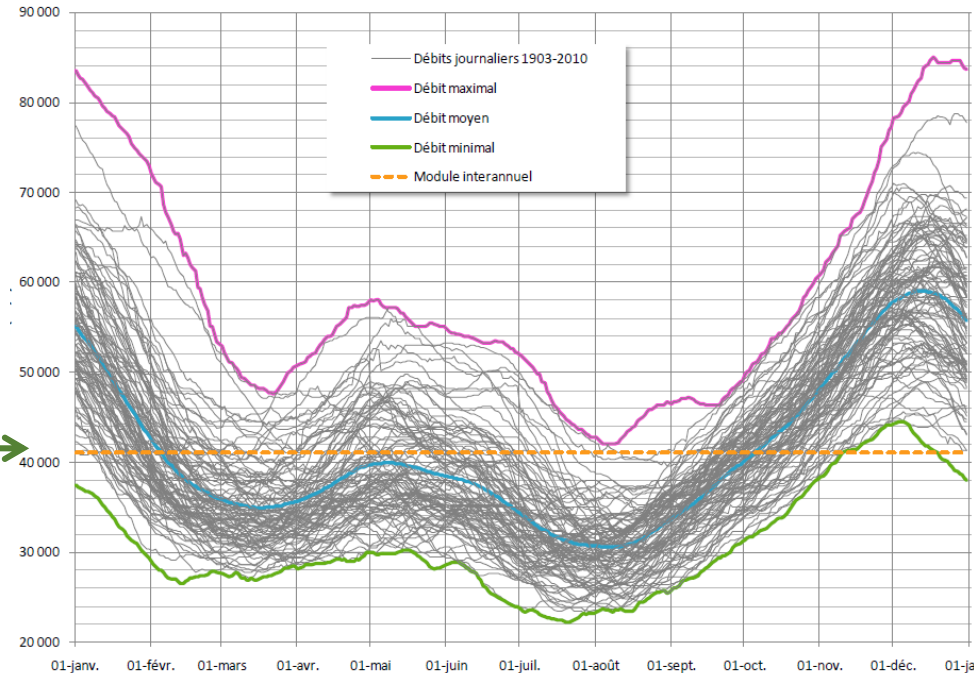
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Underestimated costs

- Another problem which should be taken into account is that the cost of annex infrastructures is not envisaged. Indeed, the size of the turbines and the need to transport construction equipment to the Inga site requires the construction of a deep sea harbour on the Atlantic at the mouth of the river Congo and the improvement of access road to the Inga site. Such infrastructures are also needed for the industries which would be located near the Inga site. The most conservative estimate made by a South-Korean consult is that the harbour alone would cost at least U.S. \$ 400 to 500 million. Other estimates made by the Organisation pour l'équipement de Banana-Kinshasa consider that the construction of railway between the harbour and Matadi would represent an investment of circa U.S. \$ 500 million. At the end of the day, the total cost of the dam, of the transmission lines and of the annex infrastructures would rather represent a cost of U.S. \$ 15 billion, including financial costs.
- Now, obviously, if the gouvernement has decided as we heard in July to go straight to phase 2 (Inga 3 High Fall) or to the phase 3 of Grand Inga (Inga 4), the total cost would be, the amount might be much higher and reach up to \$ 20 bn.
- Yet, as of now, it is unclear who is going to finance the construction of the dam. The only indications we heard from the World Bank a few years ago is that the Development Bank was considering to finance the transmission lines to Southern Africa which represents roughly 20 percent of the total cost of Inga 3 Lower Fall (4,800 MW) and less according to the new scenarios. In other words, there is a financial gap of at least \$ 12 billion and probably much more.
- One additional remark The Congolese press reported in 2015 that China which completed the 22,500 MW dam for an estimated cost of \$ 30 bn was ready technically and financially to do build and pay for Grand Inga. But such offer which was made to President Kabila during his visit to China at the time has not been reiterated.
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Site d'Inga : une hydrologie exceptionnelle

- Une hydrologie très favorable
- Plus de cent ans de données hydrologiques de 1903 à 2010
- Faibles variations annuelles de débit
- Module : 41 000 m³/s
- Etiage centennal : 22 400 m³/s
- Crue de Projet : 100 000 m³/s
- Crue de Sécurité : 120 000 m³/s



The Inga paradox

- On that point, the conclusion is that the DRC is endowed with Africa's most important hydropower potential but it has not the financial means to tap this resource alone. Furthermore, the current political instability makes it difficult for foreign partners to embark on such an important project. There is a political problem indeed. How can a government that lacks legitimacy since the expiration of the President's mandate in late 2016, commit the country for the next 20 years by increasing substantially the foreign debt burden. We are told by the World Bank that money should not be a problem. The money is there. But there is a need to ensure political stability and legal security to create the conditions for the release of funds. Another problem is that Inga like other large hydropower projects has been under attack of some NGOs, for its alleged negative consequences on the social and environmental fronts.
- Clearly, Inga finds itself in a totally different situation from the other main projects under construction in Africa.

The 6,000 MW Grand Ethiopia Renaissance Dam (GERD) on the Blue Nile whose total cost is estimated at U.S. \$ 4.4 bn. is entirely financed by Ethiopia, mainly by the government and partly by the sale of bonds by the government. Yet, the problem there is rather geopolitical. Ethiopia has to reassure its neighbours downstream that the filling of the dam reservoir will not have damaging consequences for the water supply of Egypt.

- Another country which is developing considerable hydropower capacity is Angola. Like Ethiopia, the state is financing totally the large dams on the Kwanza River : Lauca (2,070 MW) of which two turbines began operating in July 2017 and Caculo Cabaça (2,171 MW). One is financed by Brazil's BNDES bank and the other by China's Eximbank. Both represent a cost ranging between \$ 4 and \$ 5bn. Odebrecht is building Lauca, whereas China Gezhouba Group Corporation is building Caculo Cabaça.. In Angola's case, the problem is that the projects were launched before the oil price crunch and it is therefore more difficult for the state to finance these investments.
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The debate on the use of Inga's energy

- Back to Inga. An important aspect is the economic development model. The Inga 3 and Grand Inga projects are primarily designed as energy-export projects. The anchor client of Inga 3 is South Africa which is seen as providing the financial backbone and sustainability of the project.
- In the future however, the operators and managers of Inga will be confronted with the competing demand of the continent's first economy, Nigeria. For the last five years, Nigeria has already expressed its interest for purchasing up to 3,000 MW from Inga.
- **What about the domestic demand ?**
- Inga's development model has been criticised.

On the one hand, the Congolese civil society CORAP coalition considers that the 1,000 MW left to SNEL to supply the domestic market in the Inga 3 Lower Fall scenario are insufficient to meet the local needs.

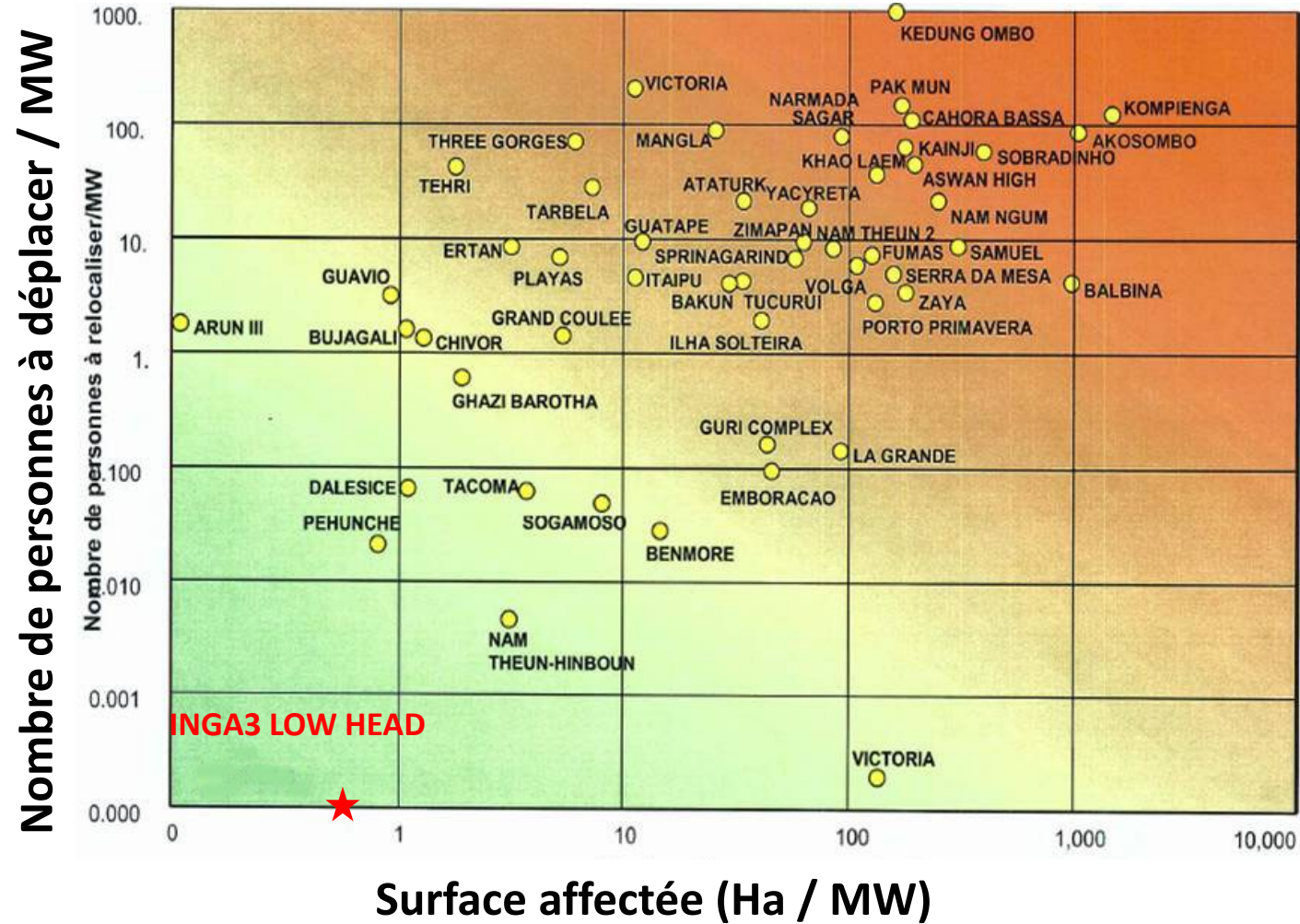
- These same sources raise questions about the governance of the project and the compensations to the people who may be removed, by the construction project. They remember that hundreds of people still ask for compensations as a result of the existing Inga 1 and Inga 2 dams. In addition, several projects including the Maluku steel plant and the CINAT cement plant which were to be financed by Inga 2 are being described as white elephants.
- But for some analysts like the former Belgian cooperation Agency director Paul Frix, the failure of CINAT and Maluku project does not mean that industrial projects built around the cheap and abundant capacity of Inga are not relevant. In 2006, BHP Billiton was considering to build an aluminium plant near Inga. The Congolese economist Venant Kinzonsi has listed a number of domestic industries which could be developed around Inga combined the abundance of electricity and of local resources (bauxite, phosphates and fertilizers, agricultural products, fisheries, etc...)

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Social and Environmental issues

- It seems consequences will be limited.
- The surface of the reservoir is fairly small, around 400 km² which is much less than the Aswan dam reservoir (6,500 km²). Besides, evaporation levels are much inferior.
- The number of people which should be displaced or affected is not that important for such a king size project. A reinstallation plan of 8,000 people was considered by the World Bank two years ago.
- The AECOM-EDF study has estimated that the affected area will be relatively small if one takes into consideration and ha/MW ratio, compared with other projects.
- A final remark however is that the financial and technical parameters of the Grand Inga project might have to be amended according to climate change. Congolese hydrologists are projecting that Congo river flows might fall by 5 percent between now and 2030 and even more afterwards.
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Zoom sur Inga 3 Basse Chute



Thank you for your attention