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Khulna Water Supply Project, Bangladesh

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Summary

Khulna city has been faced with the problem of limited access to water for many years. With less than one-quarter (~ 23%) of the total population with access to piped water supply from the Khulna Water Supply and Sewerage Authority (KWASA) water supply system, many Khulna dwellers resorted to alternative means of water supply. Drinking water sourced from shared public taps and tube wells, which in many cases are privately built were not sufficient to meet the demands burgeoning urban population of Khulna. In addition to the poor water quality of some these wells, productive time is wasted in fetching water for households, typically by women and children who engage in water fetching in the households. Saline intrusion of the two main river bodies caused by climate change has exacerbated the problem of water supply options for Khulna city. Further, unsustainable groundwater exploitation resulting from a poorly regulated well drilling and over-abstraction was becoming a threat for long-term water supply to the city. Considering these problems, KWASA, the institution responsible for water supply and sewerage in Khulna, successfully negotiated and secured a USD 363.5 million loan facility from the Asian Development Bank (ADB) and the Japan International Cooperation Agency (JICA) to rehabilitate and develop a sustainable and climate resilient water supply system (through the Khulna Water Supply Project (KWSP)) to meet the water demand of the city while reducing over-reliance of the city on groundwater resources. At the same time, the project was designed to build capacity and strengthen KWASA to provide an affordable and yet viable water supply services to Khulna city of Bangladesh.

At the time of preparation of this report, to the best knowledge of the author, project evaluation reports on KWSP were not published or made available for reference.

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Acronyms and Abbreviations

ADB	Asian Development Bank
DMA	District Metering Areas
EIRR	Economic Internal Rate of Return
FIRR	Financial Internal Rate of Return
JICA	Japan International Cooperation Agency
KCC	Khulna City Corporation
KWASA	Khulna Water Supply and Sewerage Authority
KWSP	Khulna Water Supply Project
SCADA	Supervisory control and data acquisition
SWTP	Surface Water Treatment Plant

1 Introduction

Khulna city is located in the south-western part of Bangladesh on the banks of the rivers Bhairab and Rupsha. The city spans over a 40.79 km^2 land area and with total population of over 1.50 million people as at 2014. Khulna city is considered the third-largest in Bangladesh. The city has a high rate of rural-urban migration which has contributed largely to the its increasing population. Notwith standing the increase in population growth, water supply has been inadequate to meet the demands of the rapidly urbanizing city. Reports indicated that only about 23% of the total population had access to piped water supply while the remaining uses publicly shared taps or privately developed tube wells. Further, reports indicated that Khulna city relies heavily on groundwater resources to to meet its water demands (Rafizul et al. 2012b). Rising sea levels has caused saline intrusion of the rivers of the city. Vulnerability assessments of the water sources of Khulna predicted potential saline intrusion of groundwater in the near future if abstraction rates are not curbed. Data from water supply surveys indicated that about 30,100 m^3/d of water were being supplied through 3,748 tube-wells installed by Khulna City Corporation (KCC) and 22,701 other private owned tube-wells. KWASA has 73 large 'production' tube-wells which were used to supply 900, 000 m^3 of water to Khulna city (JICA, 2011; Salauddin, 2013; Hossain et al., 2015).

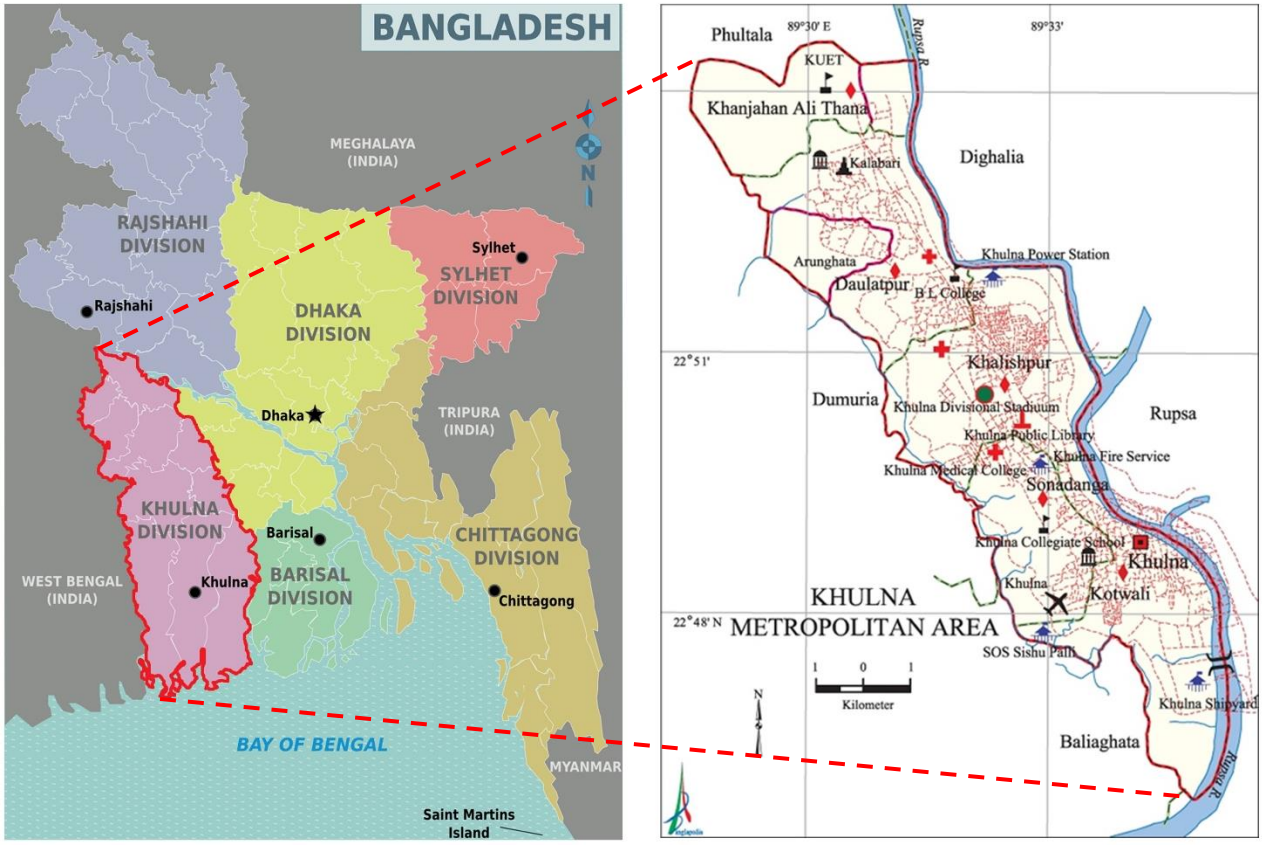

Figure 1 Geographical Map of Khulna, Bangladesh (modified from Hossain et al., 2017)

However, the distribution networks have been reported to be old and leaky due to poor maintenance and bad pipping systems. As a result, supplied water was woefully inadequate to meet the consumers demand had for piped water. Water quality of the piped network has been reported to be of poor quality. These problems made the inhabitants of Khulna vulnerable to water related health risks as well as other negative social derivatives from water insecurity, with women and children suffering greater impact.

The Khulna Water Supply Project (KWSP) was developed by the Khulna Water Supply and Sewerage Authority (KWASA) to ensure a sustainable water supply system in Khulna city. The KWASA is an independent organization, mandated to ensure the supply of potable water and of sufficient quantity to Khulna city. KWASA's mandate also includes ensuring effective planning, human resource development, and efficient operation and maintenance of the water supply system in Khulna. The KWSP was designed to ensure an expanded access to piped water.

Figure 2 KWASA public piped water in poor communities of Khulna (JICA, 2011)

The project would also ensure sustainability in groundwater extraction through groundwater monitoring and planning. In addition, the project would reduce groundwater utilization by augmentation with surface water from rivers. As well as improving the efficiency of the water distribution networks in Khulna city. To mange the project outcomes, improvement of the professional and corporate management structures of KWASA will be carried out under the KWSP.

Table 1: Overview of the Khulna Water Supply Project (ADB, 2011)

Items		Description
Project name	:	Khulna Water Supply Project (KWSP)
Type	:	Water Supply and other Municipal Infrastructure Services
Donor names	:	i) Asia Development Bank (ADB) ii) Japan International Cooperation (JICA) ii) Government of Bangladesh
Project rationale and objectives	:	Khulna city has limited access to potable water. Groundwater abstraction being the major source of water supply was being exploited unsustainably. Effects of climate change are causing rapid deterioration of rivers. KWASA needed institutional and strengthening improve service delivery. **Objectives** i) To expand the access to water supply services by building a surface water treatment plant and extending the distribution network to cover the whole city ii) To construct a surface water treatment plant with 110,000 m^3/d capacity to meet the growing demand without increasing the groundwater abstraction and undermining its sustainability. iii) To establish a climate-resilient water supply system that incorporates measures to mitigate climate impact on water supply in Khulna iv) To establish and strengthen the Khulna Water Supply and Sewerage Authority.
Total project fund	:	USD 363.5 million (ADB Funding: USD 75.0 million, Co-financing; Japan International Cooperation Agency loan: USD184 million). (Government of Bangladesh: USD 62.7 million)
Project duration		May 2011- June 2018 (Originally December 2017)

2 Technical and Technological Brief

The KWSP was designed with focus on three broad outputs. These outputs are to i) achieve augmented and sustainably managed water sources, ii) achieve extended and efficiently managed distribution network and iii) professional and sustainable corporate management. KWSP was would ensure a conjunctive use of groundwater and surface water as raw water source for treatment and supply of piped water to the city of Khulna. Under the first output, major civil works would be

accomplished. These includes the construction of an impounding reservoir and a raw water transmission main, water intake facilities and a surface water treatment plant (SWTP). In addition, deep tube wells would be rehabilitated and groundwater monitoring wells constructed. Due to the salinity of the two rivers of Khulna, the impoundments are necessary for temporary storage and mixing of saline river waters and non-saline groundwater to improve quality prior to treatment and distribution. This approach was used to improve the raw water quality while ensuring conjunctive use of surface water and groundwater.

Figure 3 Installation of production tube wells in one of the project sites (KWASA, 2011)

To achieve an extended and efficiently managed system, the output 2 of KWSP would increase access to water supply by expanding the existing distribution network as well as the construction of water transmission mains in the city. The service areas would be divided into five main blocks with each zone managed by zonal offices so as to ensure better water distribution and network management. The zonal blocks would be further subdivided into District Metering Areas (DMA) which are isolatable from the rest of the network and would improve data collection and management of water consumption, system pressure and flow.

Figure 4 KWASA staff training program on pipe laying and fitting (KWASA, 2011)

Capacity building, institutional strengthening programs and consulting services under output 3 would improve the human resource capacity and corporate management structure of KWASA. On-the-job training and professional development programs incorporated in the project design would ensure KWASA builds up the necessary skill to manage project outcomes sustainably. A corporate business plan for KWASA with a 5 years phasing period the would be developed for KWASA. The corporate business plan would include a capital investment plan, financial plan, and human resource development plan to ensure business viability of KWASA. Moreover, revenue collection would be boosted by the introduction of different tariff systems.

3 Financial brief

The total cost of the project was estimated at USD 363.5 million. The ADB funded 20.6% of the total project cost through a loan agreement (from its Special Funds resources) with the Government of Bangladesh. The loan would be repaid over 32 years with 8 years grace period. During the grace period, 1.0% interest rate would be paid on the loan while a 1.5% interest rate per annum was agreed on after grace period. JICA financed 50.6% (equivalent of USD 184.0 million) of the total project cost through a bilateral loan agreement with the Government of Bangladesh. Other cost components relating to land acquisition, taxes and duties, parts of civil works and equipment would be financed entirely by the Government of Bangladesh at an equivalent cost of USD105 million. The aggregated investment plan of the loan facilities is shown in Table 2. The terms of the co-financing are that, the construction of intake facilities, surface water treatment plant, an impounding reservoir, and a raw water transmission main would be financed by JICA while rehabilitation of deep tube wells and monitoring of groundwater, would be financed by the ADB. Network expansions and distribution, construction of clear water transmission mains as well as the training components of institutional strengthening and capacity building would be financed by the ADB. KWASA would receive loan proceeds and the counter funds from the Government of Bangladesh. However, KWASA would pay a

relatively higher interest of 2% per annum with 30-year repayment term and a grace period of 8 years.

Table 2: Khulna Water Supply Project Investment Plan (ADB, 2011)

Item		Amount (USD million)
A	**Base cost**	
	1 Civil works and equipment	283.9
	2 Consultants	18.2
	3 Land acquisition and resettlement	5.9
	4 Administrative costs	1.6
B	**Contingencies**	37.9
C	**Interest Charges During Implementation**	2.7
D	**Taxes and Duties**	58.4
	Total	**363.5**

4 Project Features

4.1 Technical and technological features

The KWSP would construct a 110,000 m^3/d surface water treatment plant (SWTP) at Samanto Sena. The plant would include an administration building and power receiving facility. A water intake facility with an impoundment would be constructed at Mollarhat on the bank of the Modhumati River in the Bagherhat District which is about 33 km from Khulna. The SWTP at Samanto Sena would receive and treat the raw water for subsequent storage in the six new reservoirs (with capacities of 300 m^3 and 500 m^3) and overhead tanks (with capacities of 5,000 m^3 to 18,000 m^3) for onwards distribution to consumers in Khulna city.

Figure 5 Construction of trenches for KWASA's water supply network expansion (KWASA, 2016)

A sludge drying bed, clear water reservoir, clear water transmission pipes of 24.6 km would be constructed. The STWP, impounding facility and clear water transmission lines would be provided with power receiving facilities, standby generator, instrumentation facilities, distribution pumps, chemical dosing and chlorination facilities (SWTP). The water intake structure would have 110,000 m^3/d capacity with a 775,200 m^3 impounding reservoir (ADB, 2011). Supervisory control and data acquisition (SCADA) system and DMA' would be used to monitor water consumption, water volume, flow and pressure in the distribution networks. Consulting services for capacity building of KWASA staffs and institutional strengthening would be carried out.

4.2 Economic and financial features

The KWSP would increase access to the piped network in Khulna from 22% in 2010 to 62% in 2018 and 80% in 2028. Access to improved quality water and extension of supply hours from 5.3 to 24.0 h/d would be achieved. Per capita water consumption would increase from 45 Lcd to 120 Lcd. This would provide many benefits to consumers especially to women and children. The economic and financial viability of the project was analyzed using the guidelines given by the ADB for appraising economic and financial performance of urban water supply projects. By these method, the economic internal rate of return (EIRR) on the project was calculated using incremental benefits and costs of the economic prices over the project's life. The economic analysis considered the valuation of the resource cost savings achievable with the project on non- incremental water consumption. The resource cost savings that would be made by switching from tube wells fitted with hand pumps to KWASA's piped network were estimated for non-domestic users of KWASA's piped water. Thus, the "with project and without projects" benefits were costed in economic terms. On the other hand, for domestic consumers, incremental consumption of piped water from KWASA was considered. It was estimated that the volume of water supplied would increase by increasing network coverage which would consequently lead to higher water consumption per person. In both domestic and non-domestic cases, the willingness to pay was quantified and used to estimate the economic viability of the project. With an economic opportunity cost assumed at 12%, an EIRR of 13.6% was calculated. The calculated EIRR was tested against downside risks, such as higher costs of project components and decreased benefits associated with the project. The assumed risk from 10% increase in capital cost and operation and maintenance cost or a 10% decrease in estimated project benefits showed that the project would still remain economically viable even under such risks.

The financial internal rate of return (FIRR) of the project was calculated by estimating the incremental costs and revenues over the project's life. Based on these, a projection of the financial position of KWASA was made which includes KWASA's taxes, revenues, and debt service. A negative financial internal rate of return (FIRR) of –2.7% (below the weighted average cost of capital estimated at 0.4%) was obtained (ADB, 2011). The unfavorable results of the estimations were attributed to the low level of planned tariff which was determined based on willingness to pay and affordability of the water supply service. However, KWAS's revenue is expected to increase because of concessional terms of relending of the acquired loan by the government to KWASA.

4.3 Social and environmental features

The social features of the project were estimated by the impact of the KWSP on the various societal settings in Khulna. Khulna city had very little access to potable piped water. As a result, people unconnected to the network were left to seek alternative sources of water. For non-domestic water users, about 40% use KWASA's hand pumps by which 64 min/d is spent fetching water, while households currently using KWASA hand pump tube wells spend on average 91 min/d fetching water (ADB, 2011). KWSP would help reduce time spent fetching water significantly. The initial social assessment report of the project noted that, the affordability of connecting to the piped network was one of the deterring factors for potential consumers to connect to the network. Thus, the project would make sure that household connections to the network are charged low prices in order to attract the poor as well as to encourage individual connections. Another benefit of the project to the various societies is the creation of jobs through the recruitment of caretakers and mangers of communal taps and DMA's.

Specific gender action plans covenanted under the loan agreement with the ADB and JICA would be strictly adhered to during project implementation. These include the reduction of the burden of women and children who often fetch water for the whole family, reduction in teenage pregnancies, HIV/AIDS and other sexually transmitted diseases that may be induced by project workers and their interaction with host communities. Also, the project would contribute to the reduction in health risks related to water insecurity. Communal tap sharing would be encouraged among low income communities and households. Labor recruitment and constitution of groups, the project would ensure women are given equal opportunities as men.

Figure 6 KWSP preparation; focus group discussions with women in Khulna (KWASA, 2011)

Reports form the projects social impact assessment noted that, involuntary resettlement caused by project land acquisition impacts the host communities significantly. The project requires about 77 acres of land in Bagerhat District and also 74.5 acre in Khulna district for the construction of water intake point, impounding reservoir, surface water treatment plant and distribution reservoir. The acquisition of such lands from the owners would cause resettlement of the owners and the loss of livelihood in some cases. However, resettlement plans involving compensations for lands acquired from people were incorporated in the project. There were no indigenous people at the project areas. Social safeguard measures designed and approved for the project would be adhered to mitigate and manage impacts on people and society at large.

Construction and civil works associated with building the water intake structures, impounding reservoir, surface water treatment plant, reservoirs, overhead tanks and the installation of transmission lines were identified to cause possible disruptions of the natural state of the various compartments of the environment. The environmental assessment reports also noted the that, project activities such as disturbance of utilities, removal of vegetation/trees, drainage congestion, air pollution due to dust, noise pollution and vibration, landscape, traffic congestion, solid/liquid waste discharge may introduce various degrees of impacts to the environment. These impacts may include the loss of various tree species, poor air quality, impacts from noise and vibrations on neighboring structures and the change of topography and landscape. Nevertheless, the environmental safeguard policies developed for and with the two co-funding partners; ADB and JICA were strictly adhered to and complied with to mitigate environmental impacts. Where possible alternative approaches would be used to avoid adverse environmental impacts (ADB, 2017).

5 Project Benefits

The implementation of the project would reduce water scarcity faced by the Khulna city. The KWSP, would expand and efficiently manage KWASA's water supply distribution network. As a result, piped water access from KWASA's water supply network would be increased. KWSP benefits directly more than 710,000 persons in Khulna city. Inhabitants connected to the KWASA water supply network would have access to clean water while existing consumers would enjoy improved services. The impact of climate change on the water resources limited the water supply options of KWASA. The rivers were saline and was unsuitable for use forcing Khulna city to be largely dependent on groundwater resources. However, with the implementation of the project, a conjunctive use of groundwater and surface water would limit the heavy dependence on groundwater resources. These would result in a sustainable, economical and efficient water resource management for the city. Groundwater abstraction levels would be informed by well monitoring data. Also, the construction of a surface water treatment plant was need to increase drinking water production capacity to meet the growing demands of the city. Significantly, groundwater and surface water utilization would provide adequate water at a good economic and financial cost of treatment to meet the growing demand.

Per capita water consumption would increase concomitantly as drinking water supply increases under the project. Thus, water security of the city would be increased. More significantly, non-water poverty would be reduced dramatically. Poor communities mostly outside the piped network of KWASA would benefit immensely. Water fetching and water carrying time would be reduced significantly. With a range of in-service programs and training aimed at improving the professional and sustainable corporate management capacity of KWASA, improved service delivery would be achieved by KWASA. Capable, competent and professional development of key staffs of the KWASA under the project would help promote improved service standards and sustainable corporate management system at KWASA. Also, to remain a viable business, consulting services procured under the project has supported KWASA to develop a 5-year strategic business plan, including a capital investment plan, financial plan, and human resource development plan.

6 Implementation status of the project

Since the inception of the project, most physical works have been completed. Regarding, project deliverables, reports indicated that progress on most works are at various stages of completion, with majority completed. Zonal buildings, distribution reservoirs and overhead tanks have been installed. Clear water transmission mains consisting of ~37.16 km ductile iron pipes (DICL) and ~537.62 km HDPE pipes have been laid in city. About 31.7 km DICL and 537.2 km HDPE pipes have also been laid as part of the distribution network improvement. Civil, structural and electrical works involved on the headquarters building and zonal offices are completed. Structural works on the eight overhead distribution reservoirs are completed. Also, the installation of clear water transmission mains which comprises 32.33 km Ductile Iron Pipe. Works on the new surface water treatment and supply system is in progress with more than 75% of the total work completed. Work on the construction of the surface water treatment plant and impounding reservoir have begun with sheet piles and piles casted. Groundwater monitoring by KWASA is on-going. Households are being connected to the new water supply system with metered connections. District metering Approach (DMAs) with SCADA would be installed to monitor the system's performance. KWASA's corporate business plan for next twenty years has been designed with 5 years phasing period. Staff training on technical and management issues are being carried out. Social and environmental impacts by the project were duly managed following the procedures detailed in the environmental and social safeguard policies of the project.

References

Hossain, E., Islam, K.T., Bashar, M.M. and Islam, M.R. (2017). Involvement of household, government and NGOs in solid waste management in Khulna city: A comparative analysis. *Journal of Civil, Construction and Environmental Engineering*, *2*(1),17-26.

Salauddin, M. (2013). Political Ecology, Stress Analysis and Capital Investment in Water Sector: A Study of Khulna City. *Journal of Bangladesh Institute of Planners*, *6*, 1-12.

ADB. (2011). *Proposed Loan and Technical Assistance Grant People's Republic of Bangladesh*: *Khulna Water Supply Project*. Manila, Philippines Retrieved July 28, 2018. from https://www.adb.org/sites/default/files/project-document/61482/42171-013-ban-rrp.pdf

ADB. (2011). *Initial Environmental Examination*: Khulna Water Supply Project. Retrieved July 28, 2018. from https://www.adb.org/sites/default/files/linked-documents/42171-013-ban-ieeab.pdf

ADB. (1997). *Guidelines for the Economic Analysis of Projects*. Asian Development Bank, Manila: ADB.

ADB. (1999). *Handbook for the Economic Analysis of Water Supply Projects*. Manila: ADB.

ADB. (1999). *Framework for the Economic and Financial Appraisal of Urban Development Sector Projects*. Manila, Philippines: ADB.

ADB. (2011). *Loan Agreement between People's Republic Of Bangladesh Asian Development Bank*; *Khulna Water Supply Project*: Manila, Philippines. Retrieved July 28, 2018, from https://www.adb.org/sites/default/files/linked-documents/42171-01-ban-sfj.pdf

ADB. (2017). *Environmental report*. *Khulna Water Supply Project*. Manila, Philippines Retrieved 28 July 2018, from https://www.adb.org/sites/default/files/project-documents/42171/42171-013-emr-en_0.pdf

KWASA. (2011). Photograph. (2011, October). *Construction and pipeline works*. Khulna Water Supply Project. Retrieved 4 August 2018: http://www.kwasa.org.bd/en/GalleryEvent.aspx?EventID=1

KWASA. (2011). Photograph. (2011, January). *Construction of pipelines and production wells*. Khulna Water Supply Project. Retrieved 4 August 2018: http://www.kwasa.org.bd/Images/IGallery/9d44dea8-0922-40b4-bb1e-44f2cf0e0c30Orgtraining.jpg

KWASA. (2011). Photograph. (2011, October). *Focus group discussion with women in Khulna*. Khulna Water Supply Project. Retrieved 4 August 2018: http://www.kwasa.org.bd/en/GalleryEvent.aspx?EventID=1

JICA. (2011). Photograph. (2011, May).*Water scarcity in Khulna*. Khulna Water Supply Project. Retrieved 4 August 2018: https://www.jica.go.jp/english/news/press/2011/110518.html

JICA. (2011). *Feasibility Study for Khulna Water Supply Improvement Project in the People's Republic Of Bangladesh: Summary Final Report*. Khulna Water Supply Project. Retrieved 4 August 2018: http://open_jicareport.jica.go.jp/pdf/12020541.pdf.