JICA PROJECT BRIEF NOTE

THE PROJECT FOR ENHANCEMENT OF INTEGRATED WATER RESOURCES MANAGEMENT IN THE REPUBLIC OF THE SUDAN

Water balance analysis and identification of issues on water resources management for the whole Sudan

October 2017

1. Background and issues

The Sudan has suffered from limited water resources such as low annual rainfall less than 300 mm in most of the country and it became constraints for economic development and daily life of people. "Water and Sanitation Policy of Sudan", prepared by National Water Corporation in 2010, analyzed that water demand, 32.1 km^3 per year, have already exceeds water resources amount of the whole country, 29.5 to 31.5 km^3 per year. Besides, increasing national population with 3.2% of annual growth rate put pressure on water balance further.

Water resources unevenly exist in regions; Non-Nile area has suffered from water shortage compared to Nile area. It is one of the main reasons of low access rate of safe water, 55%, in Sudan. Other challenge is water allocation to each water-use sectors. Currently, 90% of water is consumed for agriculture, then only 3% for drinking water. Another issue is improvement of water resources management such as hydrological observation system for groundwater and dam operation.

In this water conditions as above, it needs to update water use strategy at national level and water resources development plans based on scientific data. Besides, water resources management with improved coordination mechanism among stakeholders to reduce conflict for water allocation and enhance water use efficiency.

Issues on implementation of integrated water resources management (IWRM)

Issues of Evaluation of Water Balance (Potential-Demand) Based on the Scientific Evidence

It is necessary to monitor water resources for water resources development and management. In Sudan,

although data on rainfall and discharge in the Nile River have been collected and accumulated for more than 100 years, these data cannot be directly utilized due to delays in converting them into a digital database. As water quality monitoring has only been done in emergencies. Moreover, water levels and discharge in wadis (dry riverbed that contains water only during times of heavy rain) had been monitored before decentralization, but it is not currently being performed.

From the above, historical and locational data management and monitoring system formulations are insufficient, which in turn increases the need to implement a water balance evaluation based on the scientific evidence.

Issues of Coordination by Various Stakeholders and Active Participation

The decentralization policy has encouraged them to implement water resources development on their own terms, albeit without sufficient coordination with neighboring states. As a result, a number of water-use-related problems have occurred, such as water conflicts between water users of upstream and downstream of water resources, conflicts between farmers and nomads, and unplanned water resources development. Enhancing the problem-solving capacity of the federal government and the negotiation and coordination capacity of state governments are needed.

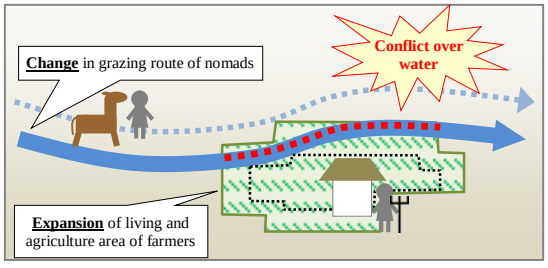


Figure 1 Conflict between nomads and farmers

Due to insufficient cooperation and coordination between the federal government and state governments, facilities are constructed in some cases without any sufficient analysis of need, priority and fairness, meaning that unnecessary facilities have been constructed while others are being poorly operated and maintained.

In terms of the rural water supply, operating and maintaining the facilities constructed by the government will be transferred to water users' organizations, however, the technical transfer and support will be insufficient, resulting in limited operation and maintenance activities by water users.

Current Legal Issues

The Water Resources Act and the National Council for Water Resources have been established and the basic principles and the roles are clarified. However, those are not functioning sufficiently because the detailed regulations and rules and so on for implementation are not formulated.

Local Society and Cultural Background

There are over 300 tribes in Sudan and their traditional administration system coexists alongside the governmental system. This traditional system, which has a big influence over conflict resolutions between tribes, cannot be ignored when consulting with nomads and farmers. For nomads in particular, the traditional system should be respected, as nomads (who make up about 10% of the population) move around Sudan, such that it is difficult to place them under the auspices of the government's administration system.

The social awareness of citizens is low regarding the necessity for them to participate in the operation and maintenance of water facilities. Therefore, many rural water facilities are abandoned or the facilities' performance falls well below the full capacity because of a lack of maintenance. Changing the mindset of both citizens and the government for water user's participation and cooperation is necessary.

2. Approach for problem-solving

Project objectives and outputs

This project aims to enhance the C/Ps' capability of the IWRM and to accomplish the project objectives and outputs considering the above issues.

Table 1 Project objectives and outputs

Objectives of the project	To make recommendations for a practical strategy, institutional and organizational framework; to improve the policies, strategies and plans for IWRM; and to contribute to the improvement of related projects
Output 1	Water balance analysis
Output 2	Analyses of issues on water resources management
Output 3	Implementation of IWRM in specific regions (pilot activities)
Output 4	Recommendations for a strategy, legal framework and implementation arrangements

This project is to be conducted in the two terms and the flowchart of the project is shown in Figure 2.

Figure 2 Flowchart of the project

Participatory activity by the C/P and participation of all the stakeholders are the main policies of the project. Recommendations for practical strategy and institutional framework and so on, which will contributes to the fair use of water among various stakeholders and the sustainable development, management and use of water resources, will be made through implementation of the IWRM.

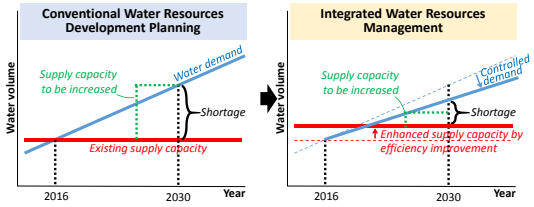
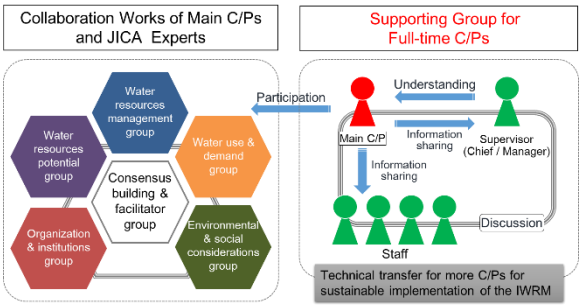


Figure 3 Image of promotion of water use efficiency by the IWRM

Implementation organization and on-the-job training

Capacity development of C/P is necessary in order to continue the IWRM activity and expand the pilot activities to the other areas led by Sudanese C/P organizations even after the project completion. Therefore, the Japanese Experts supported for implementation of the project activities by the C/Ps and capacity building was conducted through on-the-job training.

10 full-time C/Ps committed to the project activities in the first phase. Moreover, the colleagues of the full-time C/Ps were involved in the project activities and supported for data organizing and water resources potential calculation.



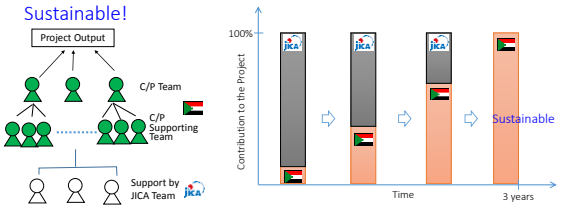


Figure 4 Implementation Organization

Assistance by the department of Wadi and Groundwater for organizing of wadi discharge data

Water balance analysis (Output1)

Output 1 is the water balance analysis based on scientific grounds. Workflow of the output 1 is as shown in Figure 5. Water balance analysis is consist of 3 elements: Water resources potential, capacity of facilities for water resources development and supply, and water demand.

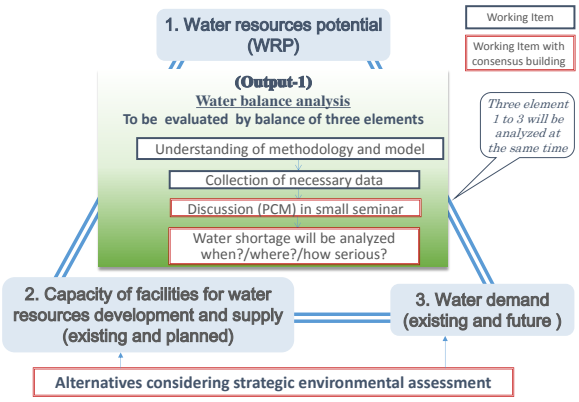


Figure 5 Workflow of the output 1

Water resources potential is calculated in individual sub-basins giving the daily rainfall and evapotranspiration data. Model parameters is set based on the soil classification. River runoff represents a surface water potential and groundwater recharge represents a groundwater potential (refer to Figure 6).

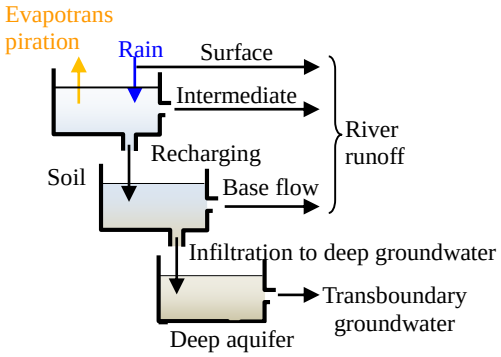


Figure 6 Image of evaluation of water resources potential

As for water demand, water demands for domestic, industry and agriculture use are calculated following the flowchart shown in Figure 7.

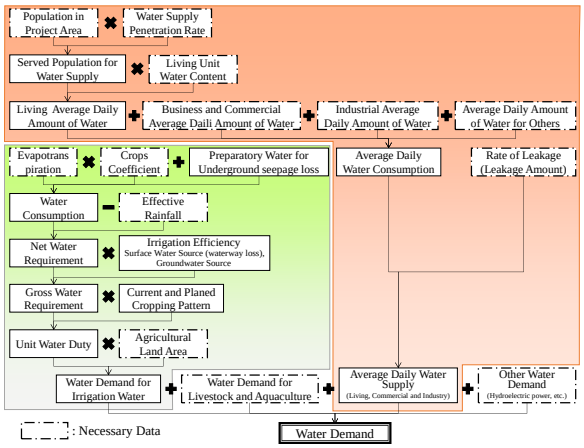


Figure 7 Flowchart of water demand calculation

Identification of issues on water resources management (Output2)

Output 2 is identification of issues on water resources management. Workflow of the output 2 is as shown in Figure 8.

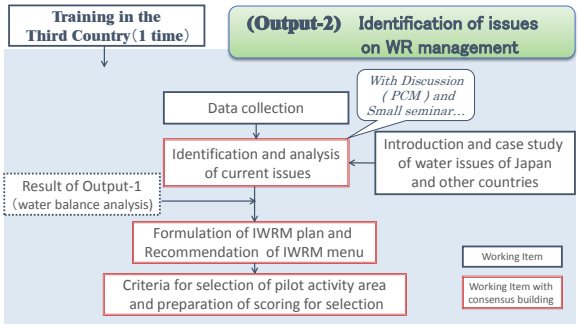


Figure 8 Workflow of the output 2

Several workshops regarding problem analysis using the PCM method are held in each C/P's organizations in order to enhance C/P's capability of identification of issues on water resources management C/P. Problem analysis is conducted and organized by category / sector, such as water supply, agriculture and so on. Genealogical tree of "Cause – Effect" is organized in the analysis (refer to Figure 9).

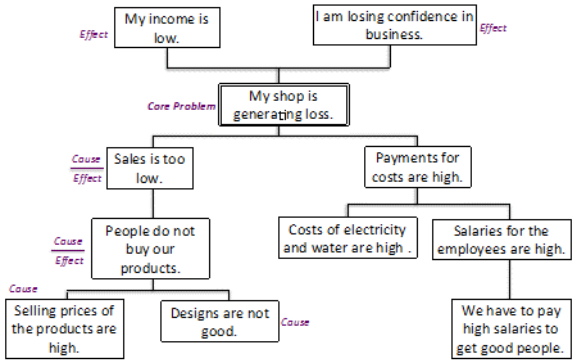


Figure 9 Image of Problem analysis tree

Training in a Third Country

Training in third country is a part of capacity development and 3 trainings will be conducted through the project. This training is one of the main objectives to establish independence and strengthen sustainability on the Sudanese side. By upgrading knowledge and awareness of C/Ps on the IWRM, this training shall contribute to the ongoing implementation of IWRM activities after project

completion and practical implementation in pilot activity areas. In addition, taking into account meteorological and hydrological conditions, such as annual rainfall with 10 ~ 800 in mm, as well as rural water supply conditions, such as taking water from groundwater, wadis and hafirs (rainwater collection pond), training in a third country in Africa will be more effective, from the view point of the similarity in meteorology and water resource conditions. In terms of similarities, such as language, religion, culture and appropriate engineering technology, it is possible to carry out efficient training.

Table 2 Tentative training program

Sites/fields for training	Explanation of selection and adoption
Morocco: Training center and treatment facilities in water supply , Water user association, etc.	Until about 20 years ago, there were many water-related issues. However, they were overcome by infrastructure developments and challenges relating to the self-help efforts for human resource development.
Tunisia: National agriculture institutes, etc.	Training to promote efficient management techniques and sustainable water resource use based on hydrology has been carried out. Training in a third country has also been carried out in order to consider efficient farming in arid areas.
Senegal: ASUFOR project site, etc.	Methods for operating and maintain rural water supplies will be learned after receiving training on ASUFOR, which offers residents autonomous management of water supply facilities and democratic organizational management.

3. Practice result of the approach

Water balance analysis (Output1)

Water balance analysis for the whole Sudan was conducted based on the calculation results of surface water resources potential (refer to Figure 10), water demand (refer to Figure 11) and capacity of facilities for water resources development.

As a result of the surface water resources potential, total annual discharge of surface water in the entire Sudan was estimated as 4.05 BCM/year, which is exclusive of the water from the Nile Rivers, the Atbara River and the outside of Sudan.

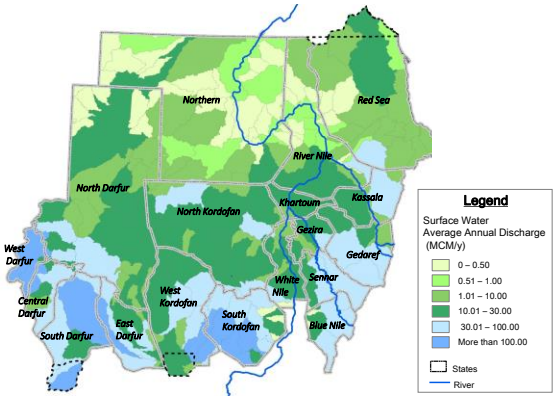


Figure 10 Calculation result of surface water resources potential

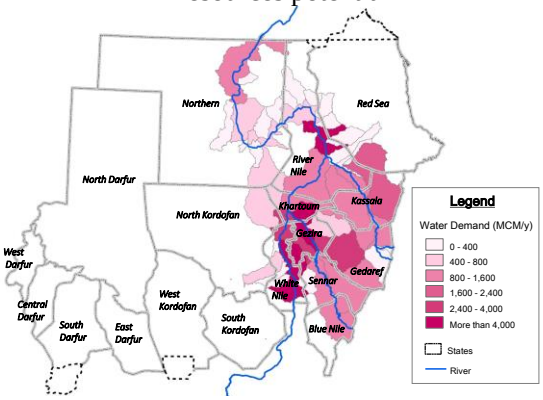


Figure 11 Future (2035) Water Demand for Irrigated Agriculture

One of the results of water balance analysis is as shown in Figure 12. Tight water supply is assumed especially in Port Sudan, Kassala, El Obeid and so on in 2035, and it will need more facilities for water resources development and supply and the IWRM approach to optimize the water use. Moreover, Figure 13 shows the calculation result of the required capacity of new facility for surface water from 2015 to 2035.

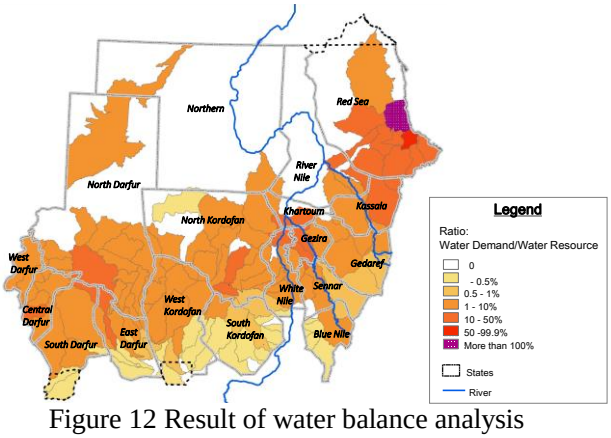


Figure 12 Result of water balance analysis (Projection for 2035)

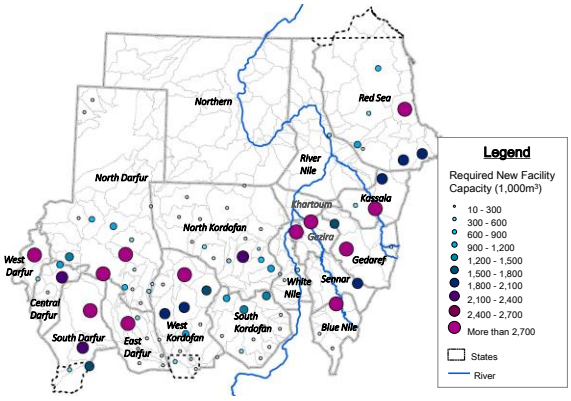


Figure 13 Required Capacity of New Facility for Surface Water from 2015 to 2035

Identification of issues on water resources management (Output2)

The problems in water resources management in Sudan were clarified through a series of problem analysis workshops with the officers of the central government ministries and organizations and some state governments, the workshops with the Japanese experts and the information collected by field surveys and discussions with related officers. Figure 17 presents the overall structure of the water problems in Sudan. Figure 14 presents its summary. "The shortage of water and bad water quality for water users" was identified as the fundamental problem. It was clarified that the factors causing this fundamental problem include supply side factors, demand side factors, water quality related factors and social, institutional and organizational factors, which are affecting all the problems.

The supply side factors are various, including underdevelopment of surface water and groundwater such as dams, hafirs and wells and deficiency of the existing facilities caused by sedimentation, leakage and declining capacities of the wells and irrigation canals. These problems are caused by the lack of information, limited technical capacity for planning, designing and implementation, inadequate budget and operation and maintenance. The demand side factors include an increase in water demand as a result of increasing population and wasteful use of water, which is caused by the flat rate water tariff system for urban water supply and the lack of farmers' knowledge on crop water requirements for irrigation water supply.

Bad water quality is caused by contamination of hafir water by animals, river water pollution by discharge of untreated industrial wastewater and seawater intrusion to the river and the groundwater in the Red Sea State, groundwater salinization in an inland area and so on.

Social, institutional and organizational problems include famers-nomads conflicts, upstream-downstream conflicts, the lack of water users' participation in water resources management, the lack of coordination among related ministries and organizations, unlimited approval of agriculture investments without technical assessment of their impacts on water resources, the flat rate water tariff system for urban water supply, uncontrolled issuance of permits to well digging, the lack of industrial wastewater control mechanism, limited application of the environmental assessment system and inadequate coordination among the general directorates and sections within MWRIE.

The problem structure explained above captures all kinds of water related problems observed in Sudan and organized them according to the cause-effects relation. This kind of problem structure is observed more or less everywhere in Sudan. Problem structures could be established in different ways in each basin and area reflecting the different levels and importance of each problem there.

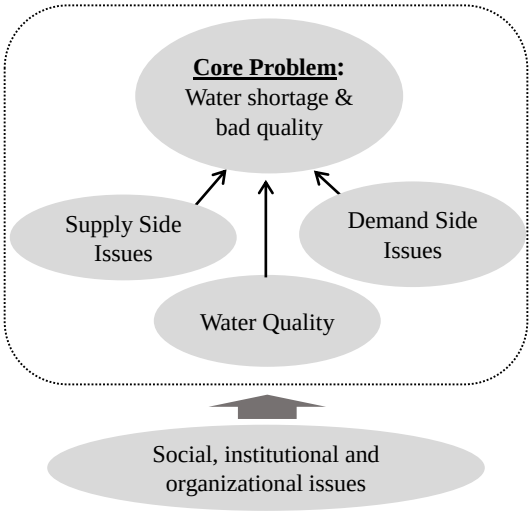


Figure 14 Problem Structure

Kassala and El-Obeid are selected as representative

regions of water issues of Sudan. These areas are proposed as target regions of the Pilot Activities Outline of the Pilot Activities are proposed as shown below.

Kassala city area

Water Issue :

Groundwater which is recharged by Gash River is extracted for city water supply and horticultural use in Kassala city area. Huge amount of groundwater is pumped up from Kassala aquifer for the horticultural activity which is causing continues draw-down of groundwater level. There is high risk of drying up of large number of wells in the near future if the current extraction is continued.

Content of Pilot Activity :

Groundwater recharge of Kassala aquifer will be evaluated, and safe groundwater development potential will be proposed by local organizations in charge of water management. Lowering of groundwater level will be predicted under the assumption that the current water extraction is continued, and safe groundwater extraction rate will be proposed in order to prevent depletion of Kassala aquifer. Countermeasures to stop over-pumping will be discussed among stakeholders for implementation.

El Obeid city and Bara groundwater basin

Water Issue :

Water supply of El-Obeid city has two water sources; groundwater sources (Al Sidir well field) in the north and surface water sources (Bagara dam) in the south. There is large question in sustainability of El Sidir well field because there is no groundwater monitoring in spite of the prediction that groundwater level will continuously decline in Al Sidir well field. Al Sidir well field is located in Bara aquifer area. Groundwater level of Bara aquifer has been declined by groundwater development of agricultural use without control. This will accurate a depletion of Bara aquifer.

Content of Pilot Activity :

Groundwater development potential of Al Sidir well filed will be analyzed to propose safe groundwater yield. The plan for optimal operation will be formulated for the south water sources to compensate groundwater sources of Al Sidir well field. Moreover, the current groundwater use of Bara aquifer will be surveyed, and discussion will be held among various stakeholders to implement aquifer management.

Training in a Third Country

Training in a third country was held in Morocco in May 2017. Trainees were the project manager, director and the full-time C/Ps and in total 13 people.

Site visit and group discussion about the comparison of IWRM in the training in Morocco

“Institut International de l’Eau et de l’Assainissement under l’Office National de l’Electricité et de l’Eau Potable (ONEE-IEA)” and “Agence du Bassin Hydraulique de Souss Massa et Draa (ABHSMD)” led the two weeks training and the trainees learned the good practice of the practical IWRM and its effects of implementation. Moreover, the trainees discussed and made some action plans to reflect the good practices and the lessons learned through the training in Sudan. “Clear social and institutional frameworks, strategies and plans”, “Scientific data for planning, involvement of stakeholders and operation (it needs

presenting the advantages of implementation of the IWRM, such as saving water and energy and cost reduction)", "Financial and operational support by the stakeholders, such as the Water User Association, and capacity development and public awareness for the stakeholders to enable it" and so on are the detailed examples of actions to be taken. It requires taking actions by the C/Ps in line with the action plans through this project or after the project completion.

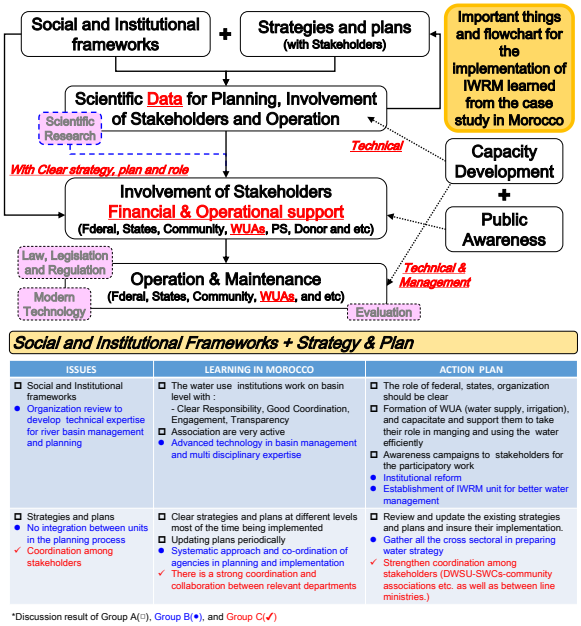


Figure 15 Example of the action plan

4. Efforts and lessons learned on the project implementation

Efforts on the project implementation is as shown in Table 3.

Table 3 Efforts on the project implementation

Efforts	Result / Impact
Facilitation at the workshops of problem analysis by the C/Ps	Each full-time C/P facilitated the workshops of problem analysis and organized the results of consultation in line with the Japanese Expert's guidance. C/Ps understood one of the process of the IWRM spiral & process, "Recognizing & identifying" in a practical way.
Weekly regular meeting	C/Ps made presentations on the progress of the activities timely at the weekly regular meeting. Minutes of meeting were made by C/Ps by rotation as well. It contributed to information sharing among the Japanese Experts and the C/Ps and enhanced the presentation skill of C/Ps.
Involvement of C/Ps in the analysis and calculations	Water potential calculation (especially, surface water) and water balance analysis were shared and conducted by all the full-time C/Ps as an on-the-job training. The whole Sudan was divided into approximately 180 sub-basins and C/Ps learned the very practical way of water balance evaluation, which have a scientific basis.
Involvement of other C/P's organization and C/Ps other than the full-time C/Ps	Other C/P's organization and C/Ps other than the full-time C/Ps supported the project activities, such as data organizing of wadi discharge, calculating of surface water resources potential, and demonstrating of ArcSWAT. The project team encouraged the involvement of other C/Ps.
Practicing a round of the IWRM spiral & process	Full-time C/Ps were enables to conduct a round of the IWRM spiral & process, especially "Recognizing & identifying", "Conceptualizing", in the very practical way as an on-the-job training as above mentioned. Since C/Ps had little practical experience of the IWRM, it will contribute to the sustainable process and activity by the C/P-led in the future.
Publication	Project leaflet was made as a publicity material (both English and Arabic versions) as shown in Figure 16. It contributed to a deepening of understanding on "participatory activity by C/P and participation of all the stakeholders".

As for the lessons learned on the project implementation, the full-time C/Ps evaluated the support and commitment by the Japanese Experts. As the evaluation result, some of the activities were substantively implemented by the Japanese Experts depending on the fields and the opportunity to take part in by the C/Ps was limited. This lesson shall be reflect in the second phase of the project.

Implementation period

Whole length: From August 2016 to August 2019

1st phase: From August 2016 to October 2017

2nd phase: From November 2017 to August 2019

Reference

Nile Basin Initiative Secretariat (2012): "State of the River Nile Basin 2012"

UNESCO (2009): "IWRM guidelines at river basin level"

K. Okamoto, T. Iguchi, N. Takahashi, K. Iwanami and T. Ushio (2005): "The global satellite mapping of precipitation (GSMaP) project, 25th IGARSS Proceedings, pp. 3414-3416"

* GSMaP_NRT is used as a part of the rainfall data (daily). "Global Rainfall Map in Near-Real-Time (GSMaP_NRT) by JAXA Global Rainfall Watch" was produced and distributed by the Earth Observation Research Center, Japan Aerospace Exploration Agency.

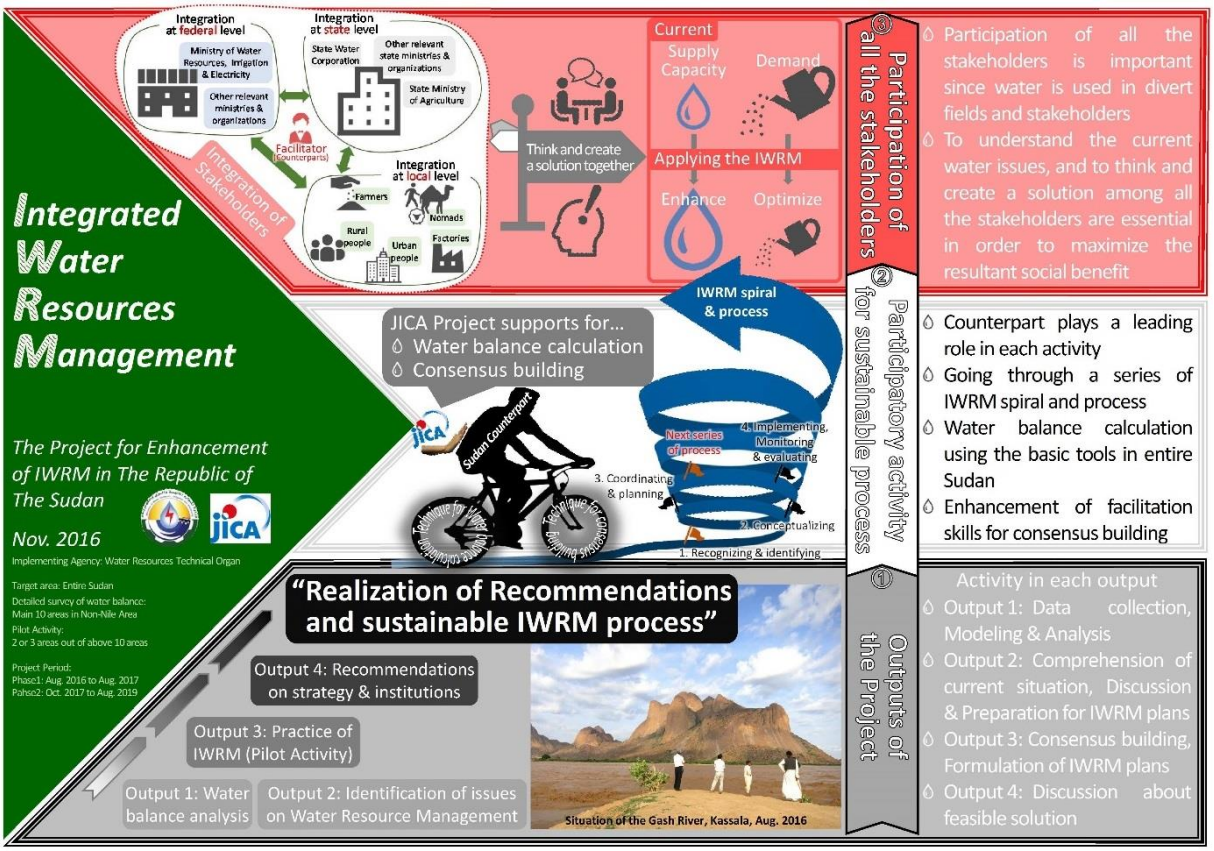


Figure 16 Publicity material (Project leaflet, adverse side)

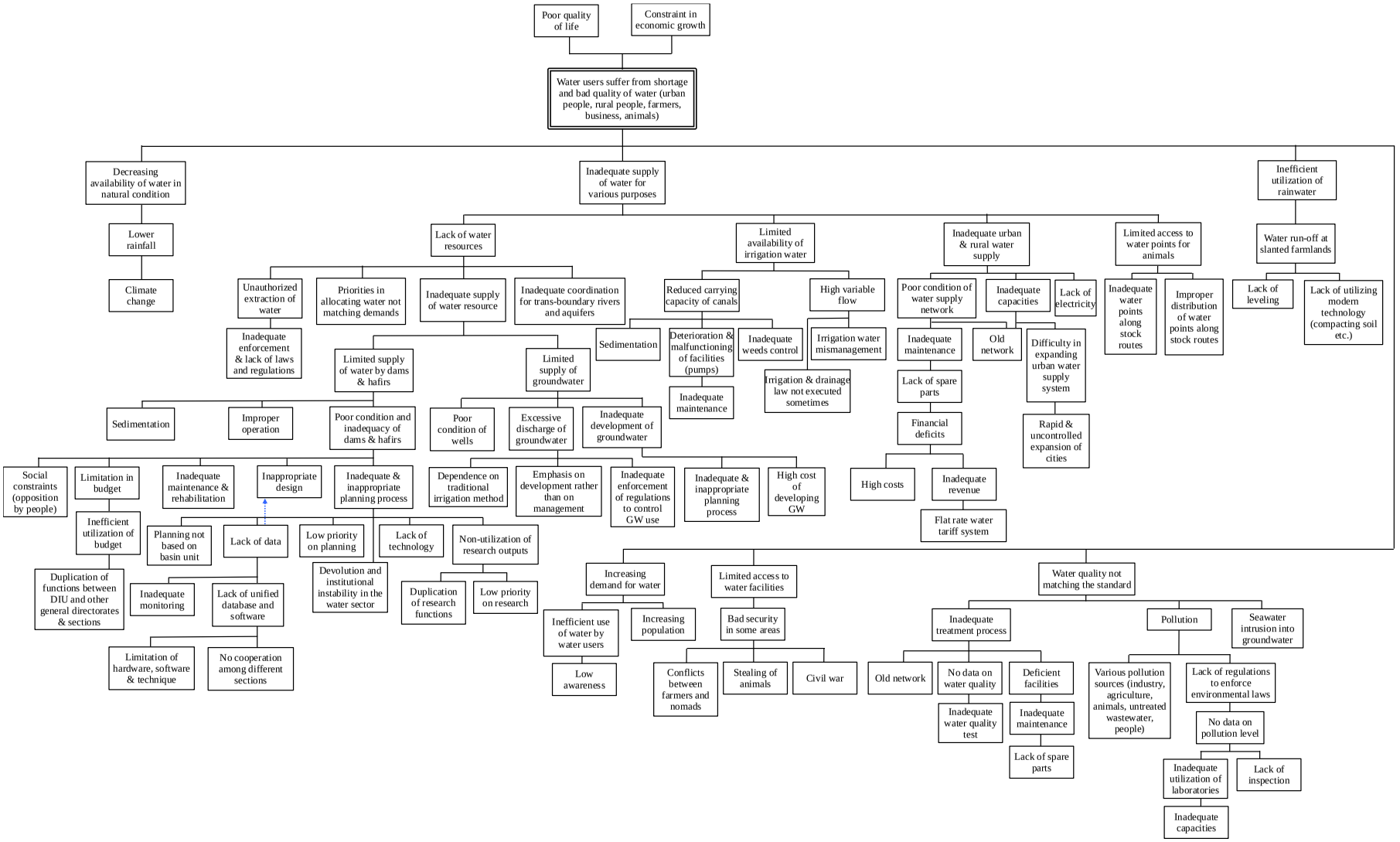


Figure 17 Overall Problem Tree for Sudan