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Progress in Integrated Water Resources Management implementation

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ABSTRACT

Integrated Water Resources Management (IWRW) has made significant strides since its definition following the Rio Conference on Sustainable Development. Part of Sustainable Development Goal 6, the implementation of IWRM is foreseen globally by 2030. Initially, planning water resources in an integrated manner was the focus of most projects/programmes; hence, nowadays most of the efforts are targeted towards its implementation with practical implications for the nations and their populations.

Successful achievements on this agenda are shared as well as challenges and possible way forward. Experiences from India, DRC and Zambia will be particularly presented and discussed. In Rajasthan (India), the devolution of IWRM was attempted at large scale from the State government to the communities. Approximatively 3,200 groups of villages (Gram Panchayat) were targeted and their integrated local plans prepared. The Congo Basin International Commission (CICOS) developed several tools for better managing this key transboundary basin of the Congo river. Spatial altimetry was largely developed throughout the basin and provides several operational applications such as for navigation services and hydropower potential characterization. In Zambia, the Water Resources Management Authority (WARMA) has established four catchment offices in four of its six catchments to better manage, develop, conserve and protect water resources.

The article concludes on the progress made by transboundary organizations and countries of two continents (Africa and Asia) towards operationalization and implementation of IWRM. It analyses the achievements, benefits and lessons learnt and concludes on the way forward to attain SDG6 by 2030.

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List of Acronyms

AMESD :African Monitoring of Environment for Sustainable Development
AU :African Union
CICOS International Commission for the Congo-Ubangui-Sangha Basin
EU :European Union
FBO :Faith-based organizations
GIZ :German International Cooperation
GMES :Global Monitoring for Environment and Security
GOI :Government of India
GOZ :Government of Zambia
INGO :International Non-Governmental Organization
IWRM :Integrated Water Resources Management
MESA :Monitoring of Environment and Security in Africa
NGO :Non-Governmental Organization
RVF :Régie des Voies Fluviales
SCEVN :Service d'Entretien des Voies Navigables
TWRM :Transboundary Water Resources Management
UN :United Nations (and their agencies and programmes)

Introduction on SDG

SDG6 is the global SDG targeting the improvement of access to water and sanitation by 2030. SDG 6.5 specifically address water resources management with its Indicator 6.5.1 on IWRM and 6.5.2 on TWRM which read as follow and shall be achieved by 2030 worldwide in order for water and sanitation in the 2030 Agenda for Sustainable Development of the United Nations to be successful.

- 6.5.1 Degree of integrated water resources management implementation (UN report-1)
- 6.5.2 Proportion of transboundary basin area with an operational arrangement for water cooperation (UN report-2)

Progress in IWRM implementation (SDG6.5.1) globally

The UN-Water, UN-Environment, DHI, GWP and UNDP have jointly prepared a Report entitled "Progress on integrated water resources management. Global baseline for SDG 6 Indicator 6.5.1: degree of IWRM implementation" in 2018. Out of 172 countries which are participating in this global effort to monitor the progress of Integrated Water Resources Management implementation worldwide, 19 % have shown very high or high implementation; 62% good; and 19% insufficient as per July 2018 (refer to Table 1, UN report, 2018).

UN-Water has launched this Integrated Monitoring Initiative for SDG6 (www.sdg6monitoring.org) with the related indicator for Targets 6.3 to 6.6 (called "GEMI") including indicator 6.5.1 on IWRM since 2014.

The UN reported that more than 80 per cent of countries have laid solid foundations to achieve at least medium-low levels of IWRM implementation but acceleration of implementation should be undertaken by countries as per 2018 status (Table 1). Regarding Transboundary water resources management (SDG6.5.2), 56% of countries still lack transboundary river basins agreements (Table 2/Figures 1&2).

Table 1: Status of IWRM progress (SDG6.5.1) in various continents (Source: UN Reports, 2018)

Percent of countries at each implementation level		Score range	Baseline	Towards 2030
4	Very high	91-100	Achieving policy objectives for IWRM: 19 per cent	Countries in this category are likely to reach the global target, or have already done so, but will need to remain focused to consolidate and strengthen gains.
15	High	71-90		
21	Medium-high	51-70	Implementing most elements of IWRM in long-term programmes: 21 per cent	Countries in this category are potentially able to reach the target, but sustained efforts need to focus on 2030 targets.
41	Medium-low	31-50	Have institutionalized most elements of IWRM: 41 per cent	**Countries in these three lowest categories (60 per cent of countries) are unlikely to meet the global target unless progress significantly accelerates.**
19	Low	11-30	Have started developing elements of IWRM: 19 per cent	**Countries in the three lowest categories should aim to set national targets based on the country context.**
<1	Very low	0-10		

Table 2: Status of IWRM and TWRM progress (SDG6.5.1 and 6.5.2) in various continents (Source: UN Reports, 2018)

Indicator 6.5.1 progress	Continent	Africa	America	Asia	Europe	Oceania
NO DATA shared (for UN report, 2018)	Africa, America, Asia	Mauritania	Canada, Greenland, Guatemala, Panama, Uruguay, USA	India, Thailand	-	-
Very high	Asia, Europe	-	-	Japan Singapore	Austria, Denmark, France, The Netherlands	
High	America, Asia, Europe, Oceania		Cuba	China, Russia	All except Iceland, Italy, Estonia, Lithuania, Norway	Australia
Medium-high	Africa, America, Europe, Oceania	Benin, Burkina, Cabo Verde, Mali, Morocco, Mozambique, Namibia, South Africa, Tanzania, The Gambia, Uganda, Zimbabwe	Brazil		Iceland, Italy, Estonia, Lithuania, Norway, Slovakia	New Zealand, The Philippines
Medium-low	Africa, America, Asia	Rest of Africa incl. Zambia (except Low and Very low ones) Lake Chad basin & Congo basin countries	Bolivia, Colombia, Mexico, Paraguay, Peru	Bangladesh, Bhutan, Brunei Cambodia, Indonesia, Kazakhstan, Malaysia, Mongolia	Serbia Macedonia	-

Low	Africa, America, Asia, Oceania	Gabon, Guinea, Liberia, Sao Tome, Sierra Leone	Belize, Honduras, Nicaragua,	Burma, Indonesia (except one island), Sri Lanka, Timor-Este, Uzbekistan	Albania Montenegro Ukraine Poland Belarus Moldavia	Papua-New Guinea
Very low	Africa	Somalia				

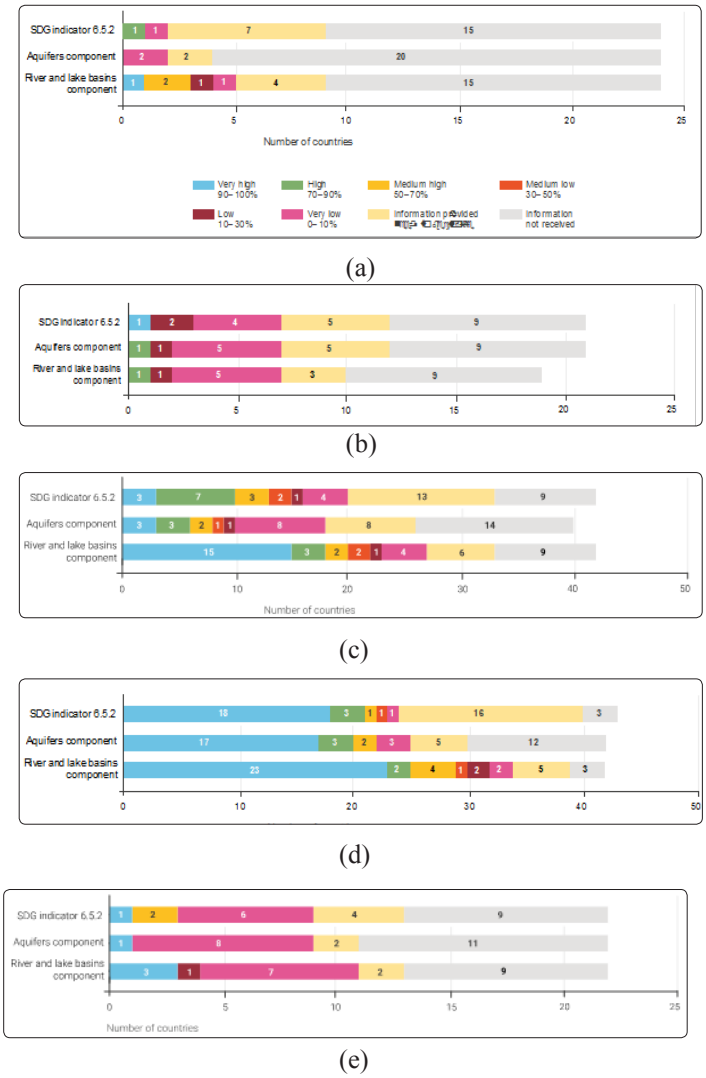

Figure 1: Status of TWRM progress (SDG6.5.2) by breakdown of the number of countries sharing waters and level of cooperation on transboundary water (aquifers, river and lake basins) for various regions (Source: UN Reports, 2018) – (a) Central, Eastern, Southern & South-Eastern Asia; (b) Northern Africa and Western Africa; (c) Sub-Saharan Africa; (d) Europe and Northern America; (e) Latin America and the Caribbean

Achievements

GWP had explained back in 2000s that IWRM was comprising of three pillars: (i) Enabling environment; (ii) Management instruments; (iii) Institutional framework.

The UN report (2018) indicates for the "Management instruments" (ii), the following implementation of IWRM by percentage of country per IWRM implementation level category (Figure 2).

On this Figure, one can see that Basin management instruments are not properly implemented in 56% of the surveyed countries; and that Transboundary data sharing, a first step in TWRM is not sufficient in 56% of the surveyed countries as well.

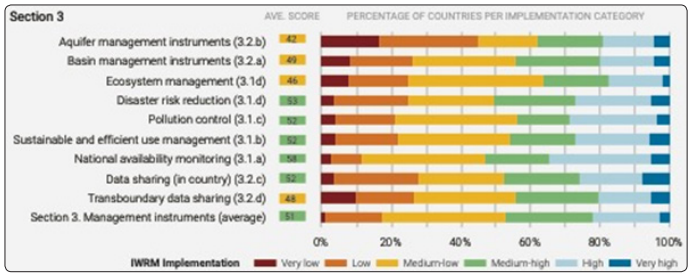

Figure 2: Status of IWRM progress (SDG6.5.1) for the implementation of the Management instruments (Source: UN Reports, 2018)

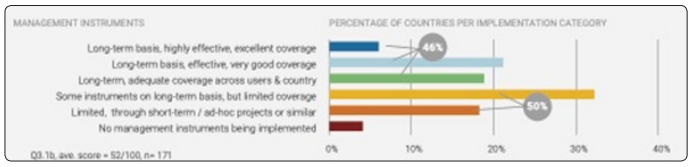

Figure 3: Status of IWRM progress (SDG6.5.1) by type of supporting programmes/ projects for the implementation of the Management instruments (Source: UN Reports, 2018)

Figure 3 demonstrates that long-term support is more likely to lead to effective and hence sustainable results (46% of recipient countries are performing well under long-term support) than short-term operations through international cooperation and/or development programmes/projects.

Progress in IWRM implementation in Congo Basin (2008-2010)

The Congo Basin International Commission (CICOS) at www.cicos.int manages transboundary water resources in the Congo Basin (area of 3,691,000 km2 and population of 77 millions inhabitants). It comprises the following five member countries: Cameroon, Congo, Gabon (0.1% of the total area), Central African Republic, DRC; and Angola, Burundi, Rwanda, Zambia are yet to join the Commission.

Navigation services have reported (Figure 4) a decrease of about 18% in the discharge of the Ubangui over the past 47 years (Source: AMESD/CICOS, 2008). The number of days when boats with a draught of 90 cm can navigate, being the minimum required for economic navigation on the Ubangui (Source: SCEVN, Brazzaville and Bangui) is reported on Figure 5. The navigation has to be stopped for a number of days per year which has increased from 4 days a year from 1935 to 1971; to 40 days a year in 1972 to 1982;107 days per year from 1983 to 1989, and more than 200 days per year since 2002.

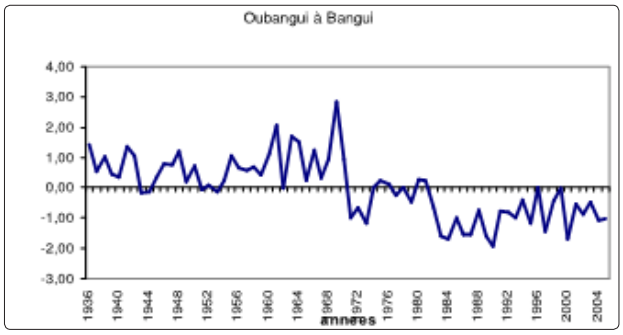

Figure 4: Variation of Ubangui river discharge from average in the period 1936-2007 (Source: AMESD/CICOS/SCEVN, 2008)

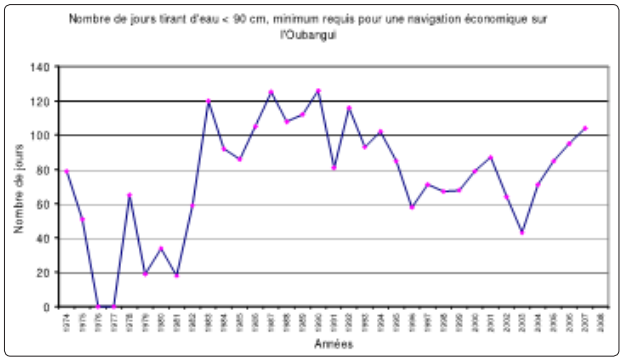

Figure 5: Variation of number of days of navigation stopped on the Ubangui river due to low waters (Source: AMESD/CICOS/SCEVN, 2008)

Satellite-based water level monitoring by CICOS through the AMESD/MESA and now GMES programmes of the African Union and the European Union led to the regular release of a water level monitoring bulletin produced every ten days and shared with these navigation services (SCEVN in CAR/Congo and RVF in DRC) to inform shipowners of their loading possibilities based on the forecasted low water level. This is an operational service developed through a combination of spatial altimetry (Figure 6) via Envisat, Jason-2, Saral & Altika, Sentinel-2B satellites, in situ data and hydrological modelling of the Ubangui river (AMESD Technical Assistance).

The Joint Research Centre (JRC) from the European Commission has developed the e-station platform to support the treatment of satellite-based information from EUMETSAT shared freely with 47 ACP African countries and received through systems set up in all these countries by the Technical Assistance with support by National Meteorological Centres.

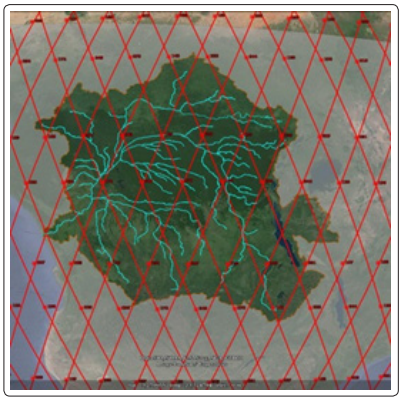

Figure 6: Spatial altimetry in Congo Basin (Source: AMESD/CICOS)

Progress in IWRM implementation in India (2010-2013)

The EU State Partnership Programme with Government of India (GoI) called "EUSPP" implemented from 2008 to 2013 (budget of 80 millions Euros) was focusing on IWRM implementation in Rajasthan State of India as a pilot programme for support to decentralization in India. Rajasthan State is one of the 29 States in India and has a size of approximatively France. It is composed of 33 Districts and the IWRM planning was undertaken with EGIS Eau support as Technical Assistance to EU/GoI: (i) by main river basins all over the State for top down approach; (ii) by Gram Panchayats (groups of villages) in 3,192 GPs in 11 Districts (1/3 of Rajasthan) for bottom up approach from 2010 to 2013. Component (i) saw the development of an IWRM information system merging hydrological monitoring of surface water resources (by Tahal) and hydrogeological monitoring of groundwater resources (by Roltha). Component (ii) included the capacity building of 300 staff of 26 Indian NGOs with the Irrigation Management Training Institute (IMTI) based in Kolta. First batch of trainings focused on GP IWRM Plans preparation with State Water Resources Planning Department (SWRPD); Second training plan and manual was prepared with Rural Development and Planning Department (RDPD) for implementation of decentralized IWRM plans.

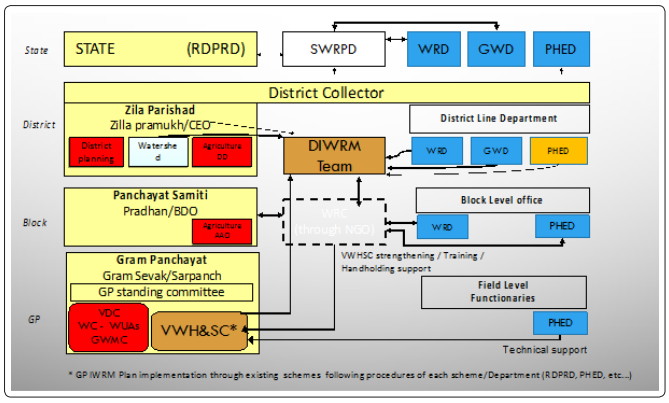

Figure 7: Decentralization of IWRM from State to lowest levels of IWRM planning and IWRM plans implementation

Figure 7 describes the organizational structure of IWRM planning and IWRM plans implementation from State to lowest planning levels.

The EUSPP had produced (i) Training manuals for both decentralized planning and implementation of IWRM and (ii) a Toolbox for the State and implementing NGOs on the three pillars recommended by GWP for IWRM Implementation.

The follow up of this programme led the Indian Government strengthening its capacities in order to implement IWRM in the country. This could be monitored by the UN against the baseline of SDG 6.5.1 and also 6.5.2 for Indus, Ganges and Brahmaputra transboundary basins.

Progress in IWRM implementation in Zambia (2017-2019)

The Water Resources Management Authority (WARMA at www.warma.org.zm) manages water resources in Zambia under the supervision of the Ministry of Water Development, Sanitation and Environmental Protection (MWDSEP). The German Cooperation supported the Zambian Government with various programmes on water resources management, namely "Integrating Climate change for water resources monitoring" until Nov. 2015 and then the "Reform of the Water Sector" programme (Sept. 2015- Aug. 2019) with final objective to introduce IWRM in Zambia. IWRM implementation is the core mandate of WARMA established

in April 2012 after the enactment of the Water Resources Management Act no. 21 of 2011 by the Government of Zambia. With support by GFA consulting group, WARMA and GIZ prepared the Kafue catchment management plan and Lower Kafue sub-catchment management plan in a participatory manner with several stakeholder consultation workshops following WARMA's Guidelines on catchment management planning, ready for approval (June 2019) and hence further IWRM plans' implementation after adequate resource mobilization by MWDSEP/WARMA.

Secondly, the level of Lake Kariba is monitored by ZRA (Zambezi River Authority - two member countries: Zambia and Zimbabwe), besides the transboundary management of Zambezi basin under the responsibility of Zambezi Watercourse Commission (ZAMCOM www.zambezicommission.org).

Regular concerns occur each year after the rainy season to find out whether the Zambezi level in Lake Kariba will allow national electricity production (expected to increase above 5,508MW (65% more) in 2035 representing an annual growth of 5.4% from 1,911MW in 2015 (in Zambia); and from 2.116MW in 2015 to 5,301MW (60% more) in 2035 in Zimbabwe (Source: ZRA). However, Lake Kariba has increased by a volume of 15 km3 over its average volume of 5,364 km3 over the past 30 years s monitored by spatial altimetry (European Commission, 2019).

Benefits

The following benefits of these programmes in terms of IWRM and TWRM progresses are indicated in Table 3 hereafter.

Table 3: Main benefits from various programmes contributing to IWRM and TWRM progress (SDG6.5.1 and 6.5.2)

Benefits for beneficiary organization	Congo Basin	Rajasthan, India	Zambia
	Transboundary	State-wise	Country-wise
Improvement of technology	Regular use of satellite data and development of advanced operational water resources monitoring systems based on river's water levels (JRC/ Thalès Alénia space/IRD/BRL/ISTA) and modelling (BRL Ingénierie)	Integrated water resources management information system developed (both surface and groundwater) is operational (Tahal/Roltha)	System in place and information products under development (UN Environment, JRC and UNESCO IHE)
Progress in water sciences	Spatial hydrology (IRD, Thalès Alénia Space) with no need for in situ monitoring; Introduction of IWRM at transboundary level (TWRM)	Better knowledge of river basins hydrology and aquifers; Pilot introduction of IWRM at decentralized levels (District, Block and Gram Panchayat)	Environmental Flows (Southern Waters/ Water Matters) and Modelling of water resources (GIZ/ GFA). Planning process and decentralization
IWRM planning	Data are made available through satellite in this large basin with little operational costs. Master Plan prepared with support by GIZ/GFA.	River-basin wise and at Districts and Gram Panchayat levels	Catchment; Sub-catchment and local levels (water user associations)
IWRM plans implementation	Not done yet	Not done yet	Not done yet
Decentralization of IWRM	Not done yet.	Done in 11 Districts out of 33 constituting Rajasthan State	Done in Lower Kafue sub-catchment
Benefits for End Beneficiaries			
	Navigation services emit every 10 days an information bulletin for navigants on safe draught for their boats.	Scheduled Casts/Scheduled Tribes (SC/ST) usually the poorest segments of the communities were heard during consultation of stakeholders and their concerns included in the IWRM plans at village level.	Local authorities, traditional authorities and water users from various categories (hydropower, commercial and subsistence agriculture, industries, mines, environmental and conservation agencies) were consulted during the planning and foreseen to become the catchment/sub-catchment councils
	Navigants load their boats accordingly increasing navigation safety.	They are also part of Village Water Health and Sanitation Committees of 25 members each including 2SC or 2ST (female and male each).	Water resources were quantified and allocation ratios among various water uses discussed and agreed among stakeholders. Hence water users will soon have a more equitable sharing of the available water resources (surface for now).
	Navigants load their boats accordingly increasing navigation safety.	300 persons recruited by 26 NGOs for the Government of Rajasthan were trained, capacitated and employed during 2 years to develop 3,196 plans.	Groundwater currently abstracted without permits is also seen as an alternative resource and better understanding is being foreseen by hydrogeological studies.

COSTS			
Donor	European Union	European Union	Germany
Budget	21 million Euros for the whole continent	80 million Euros	2.7 million Euros

Follow up

Table 4 lists the following programmes that were implemented after these ones.

Table 4: Follow up programmes in these areas

Follow up	Congo Basin	Rajasthan	Zambia
Following programmes	Monitoring of Environment and Security in Africa (MESA) – 24 million Euros Global Monitoring of Environment and Security (GMES) – 80 million Euros	Was negotiated.	Accelerated Water and Agricultural Resources Efficiency (AWARE) programme (EU/GIZ)
Expected beneficiaries	African Union countries (54), 5 RECs, 5 RICs	Government of India and population of other 28 States in terms of tools and methodologies	Smallholders farmers from Southern Province, WARMA

COSTS			
Donors	European Union	European Union	EU/Germany
Budget	104 million Euros for the whole continent		15 million Euros

Lessons learnt

International cooperation in the field of TWRM or IWRM is leading to enormous benefits for socio-economics sectors sustainability due to the fact that water resources are managed from in an integrated manner encompassing sectors such as energy, agriculture, industrial, mining, navigation, environment as well as social aspects of access to water supply and to sanitation.

Two key lessons for donors and implementers are the (i) polycentric governance of water resources and (ii) efforts required for operationalization of IWRM/TWRM through programmes/projects.

Polycentric governance of water resources

Polycentric governance of water resources is required from global to regional (continental), transboundary, national, catchment (or river basin), sub-catchment to local level of macro-catchments. Transboundary water management is leading to better international cooperation among the riparian States, improving regional integration.

At country level, India has managed to develop integrated information systems; it has also attempted to devolve its water resources management to the lowest levels not following hydrological boundaries but administrative ones, as at this level, a Gram Panchayat would be composed of several (2 to 3-5 micro-catchments) and its water management won't be possible like this. This is a hiccup in this concept's implementation. Otherwise, this has led to better understanding of both surface water resources and groundwater resources in most of the places.

Operationalization of TWRM/IWRM

Besides TWRM and IWRM plans that are a good start for foreseen the future, their implementation is key and requires different skills and support, more in terms of capacity building and field activities. Also, development of operational services is more useful than trainings only as they translate theory into practice and target end-users whom are more vulnerable or strategic than just spreading the message and methodology. Programmes could go beyond such as what has been done in Congo Basin, India and Zambia with development of operational tools to support water resources management.

A generic roadmap for implementation by Transboundary river basin organizations could be to:

1. REVISE AND REDUCE OVERALL INTEGRATED BUDGET (from the transboundary and all national IWRM plans)
2. PRESENT ROADMAP TO RBO
3. ORGANIZE ROUNDTABLE WITH RBO
4. Coordinate implementation with RBO (JOINT STEERING COMMITTEE)
5. MONITOR AND EVALUATE IMPLEMENTATION
6. CAPITALIZE LESSONS LEARNT FOR OTHER TRANSBOUNDARY BASINS

In Africa, this implementation could be fostered through REC's coordination (CEEAC, ECOWAS, IGAD, IOC, and SADC) under the overall guidance of the African Union.

Way forward to attain SDG6.5 by 2030

A way forward could be that the beneficiaries seek the support they need themselves from UN, traditional donors, private companies or INGOs, FBOs and NGOs. Donors could revise their cooperation strategies as these activities are often perceived intrusion of donors in the regions/countries and used by political parties to destabilize governments in place.

However, the UN is instrumental in monitoring progress towards SDG 6.5.1 and 6.5.2. Better reporting mechanisms should be put in place and countries could provide relevant information and data to the UN so that this monitoring can be achieved properly. Other donors will continue providing avenues and funding to attempt achieving SDG6 targets by 2030 for the benefits of the countries as well as the major water users in the world.

The UN could organize an Assembly for TWRM and IWRM with support of the International Network of Basin Organizations (INBO) for example to present the conclusions of their 2018-reports, get the information from the missing countries/ Transboundary river basin or aquifer organizations and agree on a way forward by continent [1-5].

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References

1. Julie Ladel, Pierre Nguinda, Albert Pandi, Charles Tanania Kabobo, Blaise-Léandre TONDO, et al. (2008) Integrated Water Resources Management in the Congo basin based on the development of Earth Observation monitoring systems in the framework of the AMESD Programme in Central Africa, XIIth IWRA World Water Congress, Montpellier 1-4.
2. IRD (2015) Le développement du lac Tchad https://www.editions.ird.fr/produit/9782709918367
3. Tim Busker, Ad de Roo, Emiliano Gelati, Christian Schwatke, Marko Adamovic, et al. (2019) A global lake and reservoir volume analysis using a surface water dataset and satellite altimetry Hydrol. Earth Syst 23: 669-690.
4. UN Environment (2018) Progress on integrated water resources management. Global baseline for SDG 6 Indicator 6.5.1: degree of IWRM implementation p108.
5. United Nations and UNESCO (2018) Progress on Transboundary Water Cooperation. Global baseline for SDG indicator 6.5.2. p80.