European Commission

NEPAD Western African Water Centres of Excellence

# Water Resources and River Basin Management Joint Training Course

**2014**

Report EUR 26622EN

Joint Research Centre

European Commission
Joint Research Centre
Institute for Environment and Sustainability

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This publication is a Technical Report by the Joint Research Centre of the European Commission.



JRC 89855

EUR 26622 EN

ISBN 978-92-79-37914-7 (print)
ISBN 978-92-79-37913-0 (pdf)

ISSN 1018-5593 (print)
ISSN 1831-9424 (online)

doi: 10.2788/63102 (online)

Luxembourg: Publications Office of the European Union, 2014



Printed in Italy

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# JOINT TRAINING COURSE INTRODUCTION

By adopting in 2002 the Communication on water management in developing countries, a paper setting out EU priorities for development cooperation on water, the EC recognised the crucial role of water resources management for sustainable development. The management of water resources is fundamental to achieve the Millennium Development Goals (MDGs) for which the European Union (EU) has undertaken many commitments to accelerate the progress in reaching these ambitious targets.

In 2009 the EC established a support project to the AU/NEPAD Networks of Centres of Excellence (Water CoE) in Western and in Southern Africa in order to improve the impact of African research and development on the water resource sector.

In September 2000 African countries and the international community adopted the Millennium Development Goals at the United Nations Millennium Summit. They identified that water scarcity and related insecurity due to water stress was one of the sources of the continent's underdevelopment and increasing social and economic decline. Consequently, the first African Ministerial Council on Science and Technology (AMCOST), held in Johannesburg in 2003, decided that water science and technology (S&T) would constitute one of the main flagship programmes of the New Partnership for African Development (NEPAD). Three years later, the African Ministers responsible for science, technology and water (AMCOST and African Ministerial Conference on Water, AMCOW) met in Cairo, Egypt. By resolution, the delegates committed themselves to establishing the **African Network of Centres of Excellence in Water Sciences and Technology Development**.

As a direct result of the resolution, two networks now exist with the following members:

The Southern African Water CoE members are:

- Stellenbosch University (South Africa) – coordinator
- International Centre for Water Economics and Governance in Africa (Mozambique)
- University of KwaZulu-Natal (South Africa)
- University of Western Cape (South Africa)
- University of Malawi (Malawi)
- University of Zambia (Zambia)
- University of Botswana (Botswana)
- The Council for Scientific and Industrial Research, CSIR (South Africa)

The Western African Centres Water CoE members are:

- University of Cheikh Anta Diop (Senegal)- coordinator
- International Institute for Water and Environmental Engineering (Burkina Faso)
- University of Benin (Nigeria)
- National Water Resources Institute (Nigeria)
- Kwame Nkrumah University for Sciences and Technology (Ghana)

The European Commission provided funding for these two networks, through the Joint Research Centre (JRC), with the long-term objective of enabling Africa to benefit in a more coordinated way from the existing diversity of institutions and programmes available across the continent. An added value expected is for greater south to south exchange and capacity development, with a final aim of finding ways to strengthen the link between policy and research being conducted within higher education institutions.

The AU/NEPAD Networks of CoE project was successfully concluded in October 2013. All tasks and deliverables were completed and many additional accomplishments have been achieved by the networks. Among the many results, the most important that the Western Africa network managed to achieve are to:

- Establish a network of five members from four Western Africa countries.
- Share and analyze regional data for climate variability impact on water resources availability in Western Africa. The results of the analyses will contribute to the formulation of public policies relating to water resources management, provide key information for hazard mitigation and mitigate socio-economic impacts associated with climate variability such as helping in the design of appropriate infrastructure responses to flash floods in order to reduce financial losses
- Establish important institutional relationship with AMCOW and ECOWAS (Economic Community for West African States).

One of the programme's tasks was to improve water sector knowledge development and management in the region; consequently the CoEs were requested to develop relevant educational material in the form of academic training courses.

The West African Network developed training courses on *Water Resources and River Basin Management* , composed of five modules which are presented in this book.

**The rationale behind the training courses**

- The rational centred around conducting a research, including a water stakeholder analysis and needs assessment, on how the Centres of Excellence could effectively provide sector expertise, consultancy support and advocacy towards needs in the water sector

Effective water sector policy and development for Africa, and sustainable management of water resources, must include scientific and technical research specifically directed towards meeting the needs of the African water sector and its stakeholders. In addition there is the necessity to build African human capacities by developing the required expertise and skills for the sustainable management of the available water resources. A study was therefore carried out by the Western CoEs in order to identify the human resources and capacity building needs for the water sector. This was useful to define how the Centres of Excellence could address the needs for sector expertise, consultancy support and advocacy for sector development in the region. The following table illustrates the skills gaps and training needs identified by the COE's country-based analysis.

| Area of training | Training Needs identified |
|---|---|
| Management | ○ Project Management<br>○ Project Monitoring and Evaluation<br>○ Communications – Information and Communication Technology (ICT) |
| Water resources and river basin management | ○ Conflict Resolution/Mediation<br>○ Remote Sensing and Geographic Information System<br>○ Integrated Water Resources Management (IWRM)<br>○ Water resources modeling (surface and sub-surface)<br>○ Water quality and ecology (ecological assessment and modeling)<br>○ Sediment/Coastal Engineering, Dam Design, Construction and Management<br>○ Post Flood Rehabilitation and Construction<br>○ Environmental Law and Environmental Impact Assessment (EIA)<br>○ Ecosystems<br>○ Fresh Water System Specialists<br>○ Cultural and Social Sciences –<br>○ Forestry – Forest Guards |
| Urban water and sanitation | ○ Water Distribution Systems Modelling<br>○ Hydrochemistry<br>○ Operation and Maintenance of Solar and Electric Powered Water Supply Schemes<br>○ Water Treatment Design, Installation, Operation and Maintenance<br>○ Infrastructure support, Plumbing, Advance Welding Techniques<br>○ Sewerage and Solid Waste Management<br>○ Sanitation and Hygiene |
| Rural water and sanitation | ○ Pump Operation and Maintenance, Borehole Maintenance and Rehabilitation<br>○ Geophysical Investigation Techniques<br>○ Drilling Technology, Equipment and Maintenance<br>○ Latrine Construction<br>○ Community Management of Water Supply and Sanitation Facilities<br>○ Inclusion of Water and Sanitation in Schools Curriculum |
| Irrigation | ○ Agronomy, Botany, Zoology |

The CoEs consequently decided the overarching topic would be Water Resources and River Basin Management. This was based on discussion of the results of the study on needs, with the modules proposed by the CoEs consisting of:

| Water Resources and River Basin Management |
|---|
| ○ **Frameworks for Integrated water resource management - UCAD**<br>○ **Water Allocation and Demand Management- KNUST**<br>○ **Environmental Impact Assessment – U of Benin**<br>○ **Post-Construction Monitoring and Evaluation - U of Benin**<br>○ **Conflict Resolution in River Basin Management-NWRI** |

**Western Africa COE Training Courses Summaries**

**Module 1: Frameworks for Integrated Water Resources Management**

The Integrated Water Resources Management course aims to familiarize participants and experts working in the field of water resources management with IWRM tools and principles. **Unit 1** is an introduction to the IWRM principles and reviews the challenges of the African water situation. **Unit 2** gives an overview of the different IWRM definitions and water governance related issues in the African continent as well as illustrating the different methods and tools recommended in the implementation of IWRM principles. **Unit 3** illustrates the Lac de Guiers case study.

**Module 2: Water Allocation and Demand Management**

The module has three units which will cover the following:

**Unit 1:** introduction to water resources and the hydrologic cycle; uses and importance of water resources; impact of human activities on water resources quantity and quality; integrated water resources management principles and integrated water resources management (IWRM). **Unit 2:** the purpose of water allocation; objectives and principles of water allocation; scale of water allocation within basin; uncertainty in water allocation; legal framework and water rights for water allocation; principles of transboundary water allocation; priority of water allocation between sectors; water allocation mechanisms; integrated water allocation planning and modelling; case study: water allocation in Volta river basin shared by riparian countries. **Unit 3**: water demand management including water use efficiency; public awareness and education; water demand management measures; water losses management; water demand management options modeling.

**Module 3: Post-Construction Monitoring and Evaluation**

The manual discusses the concept, methods of data acquisition and analysis and reporting in post construction monitoring and evaluation.

**Unit 1** introduces participants to the concept of monitoring and evaluation and then post construction monitoring and evaluation both in natural environment and in conflict situations. **Unit 2** discusses the laws, policies and institutional arrangements in post construction monitoring and evaluation. Also discussed in this unit are the building of capacity, bias and errors that are likely to affect the outcome of PCM&E results. **Unit 3** describes the purposes, scope and practices of PCM&E. **Unit 4** explains the issue of performance question, information needs and indicators used in PCM&E. In **Unit 5**, the components of a PCM&E, key steps in setting up a PCM&E programme and critical reflection on how people (i.e. stakeholders) can make sense out of the data generated for PCM&E is evaluated. Also discussed in the section are financial and human resources needed for a PCM&E programme. The section went further to discuss the terms of reference for a PCM&E programme, the purpose, scope and objectives of evaluation, team composition for evaluation, time frame required and cost of evaluation. Finally, the unit summarizes the components of a sustainability evaluation for a water and sanitation project. **Unit 6** examines information gathering, analysis and data management in PCM&E and the issue of of Quality Assurance and Quality Control are discussed. Thereafter, a typical water and sanitation monitoring programme is presented as a guide to participates on indicators and parameters to be monitored, issued to be defined and evaluation option.

Finally, a typical programme for a case study in PCM&E post construction monitoring and evaluation of the Kainji Dam in Nigeria is presented.

**Module 4: Environmental Impact Assessment**

The manual has been designed to meet the basic needs of stakeholders in understanding the concepts, methodologies and application of Environmental Impact Assessment (EIA) in the development of water resources and sanitation projects. **Unit 1** introduces participations to the concepts of EIA, its aims and objectives, historical development, legal and institutional framework, scope of application and public involvement. In **Unit 2**, screening and scoping in EIA is discussed. The section is concluded with Establishment of Environmental Baseline. In **Unit 3**, Impact identification, prediction and evaluation are presented. The section is concluded with a typical impact analysis including impact identification, prediction and evaluation for a water project. **Unit 4** discusses impact mitigation and impact management. The components of an environmental management plan, monitoring, auditing and evaluation are also presented in this Unit. The method generally adopted in EIA reporting is presented. The Unit concludes with a Trans-boundary EIA for water supply and sanitation EIA project. Finally, in Unit V a case study of Environmental Impact Assessment is presented using the Gurara Dam water supply EIA Project.

**Module 5: Conflict Resolution in River Basin Management-NWRI**

This course is mainly a training of trainers focusing on conflict resolution and community involvement in river basin management under the framework of Integrated Water Resources Management (IWRM). Attention is given to water resources issues, IWRM, conflict analysis and resolution instruments and community involvement in river basin management. The implications for sustainable water management will be also addressed. Emphasis is given on practical examples of issues in the African region in order to share experiences. The sessions are designed to be interactive to bring out varied experiences.

At the end of the course participants will be able to:

- Link water resources issues with IWRM and conflict resolution in water resources management;
- Identify factors that can escalate conflict with stakeholders and also factors that can prevent conflict;
- Apply a variety of conflict resolution skills for effective participatory, consensus building, and conflict management processes in water resources management;
- Design and facilitate community participation process, as is needed in river basin management;
- Identify and select appropriate techniques for a participatory process;
- Design river basin water user organizations and frameworks for action.

# Module 1

# GESTION INTEGREE DES RESSOURCES EN EAU

**RESPONSABLE DU COURS, AUTEURS ET INTERVENANTS**

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**RESUME**

Ce cours axé sur la gestion intégrée des ressources en eau vise à améliorer le niveau de maîtrise de ce concept et les méthodes et outils de sa mise en œuvre. Le cours est organisé en 4 modules distincts qui se présentent comme suit :

L'unité n° 1 est une introduction aux principes de la GIRE ; elle rappelle les enjeux et introduit la situation de l'eau en Afrique et dans le monde. Ce module rappelle la disponibilité et les contraintes des ressources en eau rencontrées dans le cadre sa gestion. L'unité n° 2 couvre les principes directeurs et définitions de la GIRE et passe en revue les différentes méthodes et outils préconisés pour sa mise en œuvre. L'objectif donc de ce module est d'évaluer les mécanismes garantissant une gestion durable des ressources en eau. Les expériences vécues seront évoquées. Les solutions appliquées feront l'objet d'échange, de discussion et d'évaluation entre les participants

L'unité n° 3 sera consacrée essentiellement à réalisation d'un exercice en classe sur le cas du lac de Guiers.

**OBJECTIFS DU COURS**

Le cours de « Gestion intégrée des Ressources en Eau » vise à familiariser les étudiants et les cadres travaillant dans le secteur de l'eau et de l'environnement aux principes et outils de la GIRE. A la fin du cours, les participants auront la capacité de : conseiller les décideurs, mener des médiations au niveau du système de gestion et au niveau des usages, concevoir des projets de gestion de l'eau, faire des communications sur la thématique et finalement d'administrer et de procéder à une gestion planifiée des ressources en eau.

La formation à travers les différents modules devra déboucher sur une vue globale des éléments de stratégie d'une gestion intégrée des ressources en eau. L'accent sera mis sur les mesures et approches à promouvoir dans la perspective d'une exploitation durable des ressources en eau et de leur répartition équitable entre les différents usages.

Les objectifs de cette formation restent de :

- Informer les participants sur les enjeux liés la gestion de l'eau; de l'évolution de la demande par rapport à la disponibilité de l'eau en Afrique et dans le monde
- Introduire les participants aux principes de gestion intégrée des ressources en eau
- Doter les participants des méthodes et outils nécessaire pour une gestion intégrée des ressources en eau et les appliqués sous forme d'un exercice final.

Les maîtres mots de cette formation sont : la gestion des ressources en eau, le développement durable, la planification des ressources en eau, les programmes et projets de gestion de l'eau, les modèles hydrologiques, hydrogéologiques.

**LE GROUPE CIBLE**

Les étudiants doctorants, les gestionnaires des ressources en eau aux niveaux publics et privés, les responsables d'ONG travaillant dans le secteur de l'eau, les ingénieurs hydrologues et hydrogéologues, les décideurs et chercheurs.

**METHODES ET OUTILS DE FORMATION**

Le Cours va s'organiser sous forme de cours magistral suivis de travaux dirigés et d'études de cas; il sera demandé aux participants de discuter et d'échanger leur propre expérience à travers des ateliers en classe.

## Table des matières

# 1.0 INTRODUCTION

Ce cours sur la gestion intégrée des ressources en eau sera axé sur les problèmes de gestion de cette ressource en tenant compte des facteurs de nuisances et de contraintes pour mieux répondre aux orientations politiques de nos pays en voie de développement en s'inspirant des expériences enregistrées à travers le monde.

L'importance de l'eau tient au fait qu'elle se situe au carrefour de deux grandes préoccupations humaines : les ressources naturelles vitales et l'équilibre éco-dynamique de la planète.

Le programme de ce cours porte sur la recherche et la formation visant à aider les populations à mieux gérer leurs ressources en eau dans la mesure où « *l'eau est la condition première indispensable à toute manifestation vitale* » (Claude BERNARD[1]).

Le cours logé au sein de l'École Doctorale vise à :

- participer à une connaissance plus approfondie des besoins en eau potable mais également de l'offre en termes de quantité et qualité
- maitriser les outils et techniques permettant une bonne conception et mise en œuvre de la GIRE;

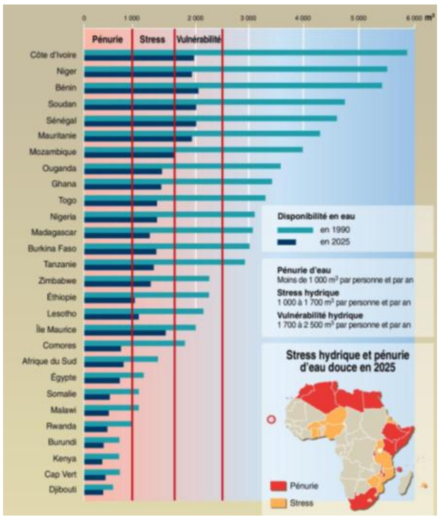
## 1.1 Contexte et justifications

Le choix de la gestion intégrée des ressources en eau opéré par les pays de l'Afrique de l'Ouest en 1998 lors de la conférence ouest africaine sur la GIRE a été renforcé lors du Sommet Mondial sur le Développement Durable de la Planète Terre de Johannesburg en 2002, où la Communauté Internationale a pris l'engagement d'aider les Etats à se doter d'un plan d'action nationale GIRE avant fin 2005. C'est également au cours de ce Sommet que la GIRE a été établie comme l'élément clé pour la réalisation des Objectifs du Millénaire pour le Développement (OMD) particulièrement dans le secteur de l'eau.

La GIRE prône la coordination et la coopération entre les secteurs, la participation des acteurs, la transparence et une gestion locale à moindre coût. Elle offre la perspective d'une plus grande efficacité, d'une préservation de l'eau et de la nécessité de la gestion d'une eau équitablement répartie entre ses usagers au lieu de l'exploitation de nouvelles réserves.

En plus de la nécessité d'assurer un accès équitable et durable à l'eau pour tous les usagers y compris les femmes et les populations pauvres et les plus défavorisées, la GIRE met aussi l'accent sur la protection des écosystèmes terrestres en amont des bassins versants qui sont très importants dans le processus de recharge des nappes souterraines et le régime des débits des fleuves, ainsi que des écosystèmes aquatiques qui apportent divers biens socioéconomiques aux communautés.

## 1.2 Disponibilités de la ressource




L'eau occupe environ 70% de la surface de la terre, en grande partie sous forme d'océans. En volume, 2.5% seulement de toute l'eau de la Planète est douce. Trois-quarts environ de cette eau douce sont bloqués sous forme de calotte glaciaire et de glaciers situés dans les régions polaires, loin de toute habitation humaine, donc pas accessible pour l'homme.

Seulement 1% environ de cette eau est facilement accessible sous forme d'eau superficielle; il s'agit essentiellement de l'eau des lacs, des rivières et des eaux souterraines situées à des profondeurs permettant de les capter moyennant un coût raisonnable.

En somme, la fraction d'eau utilisable sur terre représente environ 200 000 km$^3$ – moins de 1% de l'eau douce et seulement 0,01% de l'ensemble de l'eau présente sur terre (PNUE 2002). Il s'agit de la quantité régulièrement renouvelée par les chutes de pluie et de neige et qui est donc disponible de façon durable.

### 1.2.1 Eaux de surface / Eaux souterraines

Les eaux de surface comprennent les eaux courantes (cours d'eau : rivières, canaux) et les eaux stagnantes ou plans d'eau (lacs, retenues de barrage, étangs, etc.).
Les eaux souterraines constituent une provision d'eau potable inestimable pour l'humanité. Plus de 95 % de l'eau douce disponible sur terre est stockée dans des nappes phréatiques. Les eaux souterraines, dans la satisfaction des besoins en eau des communautés humaines, ont toujours complété les ressources fournies par les eaux de surface. Selon le GEO (2003) citant PNUD et autres (2000) «deux milliards de personnes environ, soit à peu près un tiers de la population mondiale, dépendent des eaux souterraines, et tirent de la terre environ 20% de l'eau consommée (600 à 700 km$^3$) chaque année ». Dans plusieurs pays, c'est pratiquement la seule source d'approvisionnement. Leur importance est fonction de leur localisation, étant situées à des profondeurs très variables et souvent d'accès difficile.
Les eaux souterraines contribuent à l'alimentation des cours d'eau et leur rôle est essentiel. Elles sont exploitées pour la consommation humaine (eau potable), l'agriculture (irrigation) et l'industrie (eau industrielle). L'importance économique et environnementale des eaux souterraines fait de leur préservation un enjeu de développement. Dans l'avenir l'importance des eaux souterraines sera de plus en plus importante ainsi que la dépendance des populations à leur égard.

### 1.2.2 Bassins côtiers

Les deux tiers de la population mondiale vivent à moins de 500km de la mer. A l'exception de l'Inde, la plus grande partie de la population de l'Asie vit en bordure de la mer. En Chine, par exemple, près de 60 % de la population de 1,2 milliard d'habitants vit dans 12 provinces côtières, le long de la vallée du Yang-tze et dans deux municipalités de la côte — Shanghai et Tianjin, la densité de la population se situe en moyenne entre 110 et 1.600 habitants au kilomètre carré.

Par contre en Afrique il y a plus d'habitants à l'intérieur du continent que le long ou à proximité des côtes. Cependant, depuis une vingtaine d'années, les villes côtières d'Afrique — qui sont des centres d'échanges et de commerce — voient augmenter leur population d'au moins 4 % par an, au fur et à mesure que des millions de gens quittent l'intérieur du pays. Par exemple, Accra, Abidjan, Dakar, Dar es-Salaam, Lagos et d'autres villes côtières ont vu leur population se gonfler à la suite des migrations internes.

Quand des activités humaines endommagent les écosystèmes d'eau douce, elles finissent aussi par endommager l'environnement. Les océans sont reliés à la terre par un réseau complexe de fleuves, de ruisseaux et de lacs qui forment des bassins versants. Une meilleure gestion des ressources en eau douce aidera à protéger les eaux côtières. La protection de l'environnement côtier, au lieu de la transformation des océans et des mers en dépotoirs, aiderait à éviter à l'avenir un désastre écologique possible.

### 1.2.3 Aquifères urbains

Une grande partie de la population mondiale vit dans des villes et des zones urbaines. La majeure partie de la croissance démographique se concentrera dans le monde en voie de développement. En Afrique les taux de croissance urbains seront accentués par les conditions climatiques défavorables, la désertification et la pauvreté, qui affectent de nombreuses zones du continent et poussent les populations à émigrer vers les grandes villes. Principale source d’eau dans beaucoup de villes africaines, les aquifères urbains, devront répondre à une demande croissante tout en étant exposés à des arrivées massives de sources de pollution urbaine, telle que les produits chimiques organiques, pesticides, nitrates, métaux lourds et éléments pathogènes véhiculés par l’eau. En 2002 une étude du PNUE a évalué les répercussions de la pollution sur les aquifères dans dix villes africaines (Abidjan, Dakar, Cotonou, Accra, Ouagadougou, Bamako, Niamey, Lusaka, Addis-Abeba, Mombasa), analysant les dommages causés par l’exploitation effrénée des eaux souterraines et par le rejet de déchets de toutes sortes, qui ont accompagné l’expansion urbaine et se sont traduits par une pénurie croissante de l’eau dans les villes et la détérioration de sa qualité.

### 1.2.4 Ressources en eau au Sénégal

Au Sénégal, en 2003, une étude du Ministère en charge de l'eau au Sénégal, a évalué de manière exhaustive les eaux de surface du Sénégal drainées par les bassins hydrographiques :


- le Sénégal avec un volume moyen annuel écoulé estimé à 20,4 milliards de $m^3$ à la station de Bakel ;
- la Gambie avec un volume moyen annuel écoulé estimé à 3,44 milliards de $m^3$ à la station de Wassadou ;
- la Casamance qui présente la particularité de la remontée de l'onde de la marée le long du lit du fleuve, son volume moyen annuel écoulé est estimé à 46,4 millions de $m^3$ à la station de Kolda ;
- la Kayanga (Anambé) dont le volume moyen annuel écoulé au site du barrage de l'Anambé est estimé à environ 102 millions de $m^3$.

En plus de ces cours d'eau, il convient de prendre en compte des unités hydrologiques telles que le lac de Guiers et les mares du Ferlo. Toutefois malgré toutes ces ressources, dans certaines zones du pays comme le Ferlo l'accès à l'eau est assez difficile.

Les apports des cours d'eau sont évalués à 31 milliards de $m^3$ en année moyenne.

Il faut ajouter les aquifères qui renferment l'essentiel des eaux du pays. Il y a deux grands ensembles:

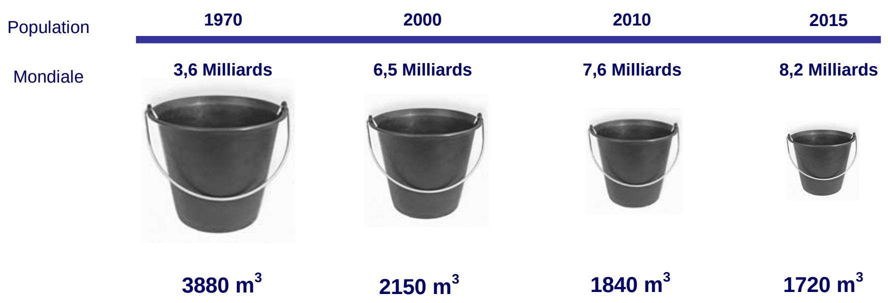
- le bassin sédimentaire sablo-argileux qui couvre les 4/5 du territoire avec plusieurs aquifères superposés aux potentialités énormes (superficiels de 50 à 75 milliards de $m^3$, intermédiaires de 50 à 100 milliards de $m^3$, profonds de 300 à 400 milliards de $m^3$)
- le socle cristallin à formation discontinue qui couvre le reste du pays, on y tire environ 3,6 millions de $m^3$ avec des débits variant entre 6 à 10 $m^3$/h

## 1.3 La Crise de l'eau: une Planète assoiffée ?

La population mondiale augmente et accroît la pression sur les ressources en eau douce ; ainsi les antagonismes se renforcent entre les usagers de l'eau mais aussi entre les différents usages. En Afrique les populations doivent se partager des ressources en eau insuffisantes, de qualité médiocre et surtout très mal réparties. L'action de l'homme, à travers l'agriculture, l'urbanisation et l'industrie, ne fait qu'accroître les difficultés à disposer d'eau douce en quantité suffisante.

Dans les décennies à venir, l'eau douce risque de manquer en quantité et en qualité. En Afrique, certaines situations locales sont déjà dramatiques, particulièrement dans le Sahel. Le Congo et ses affluents reçoivent environ 30% des précipitations annuelles de l'ensemble du continent africain, mais son bassin renferme seulement 10 % de la population du Continent. Par pays, le volume d'eau douce renouvelable disponible par personne sur une base annuelle, selon des estimations de 1995, va de plus de 600.000 mètres cubes en Islande à seulement 75 mètres cubes par personne au Koweït.

A une autre échelle, les inégalités entre riches et pauvres ne sont jamais aussi importantes que sur le plan de l'accès à l'eau.

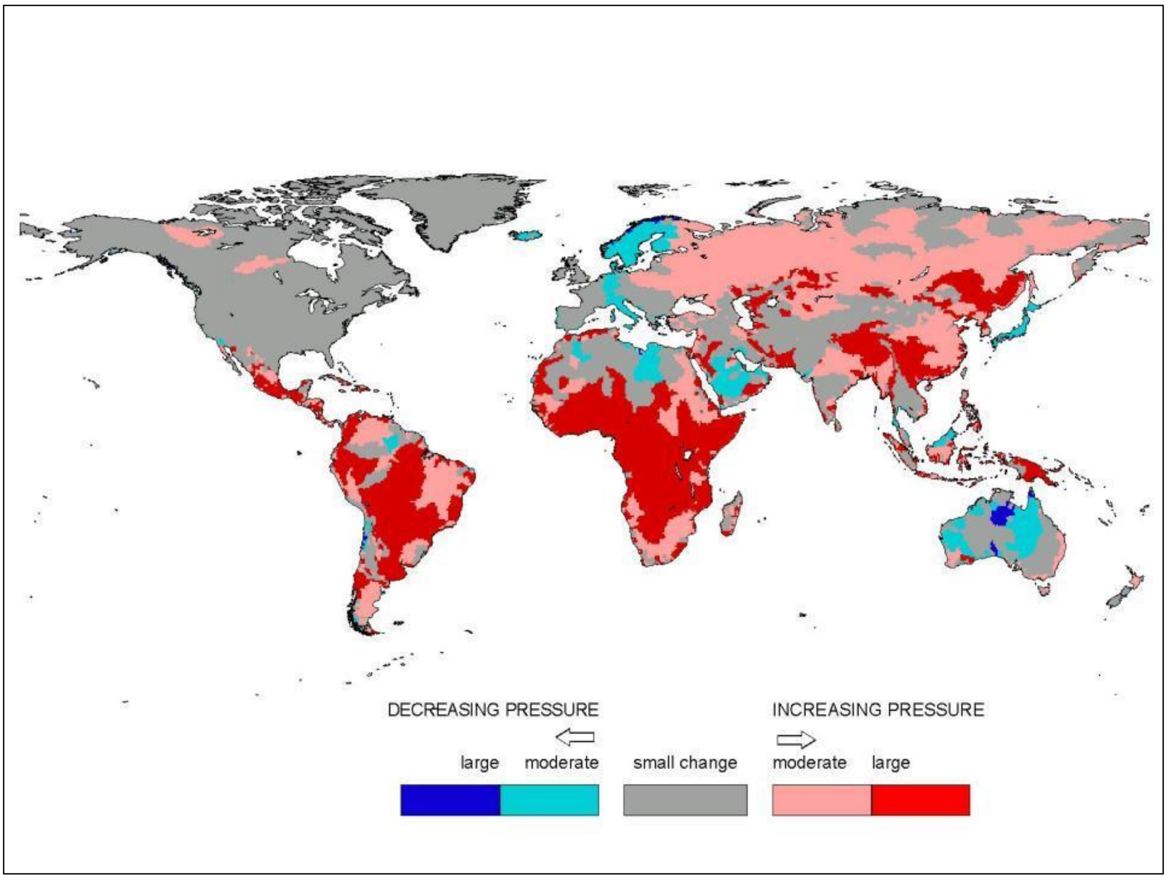



**Reinhold Castensson (1998) Modifié**

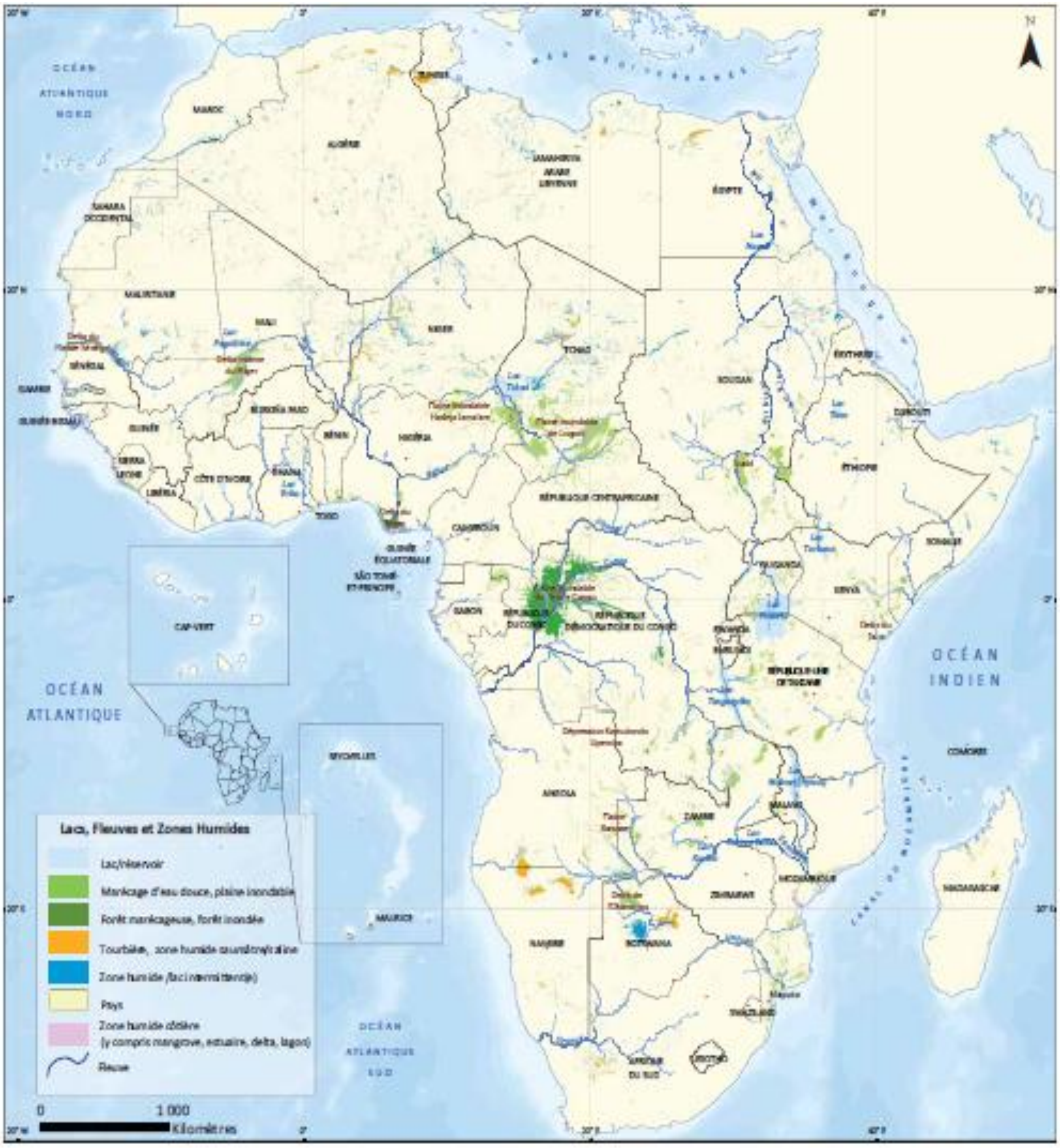
Des années de croissance démographique rapide et d'augmentation de la consommation d'eau par l'agriculture, l'industrie et les municipalités ont mis à rude épreuve les ressources mondiales en eau douce.

Les inquiétudes sont nombreuses car les régions du globe menacées de pénurie sont de plus en plus nombreuses et continuent de s'étendre, alors qu'une population en augmentation constante exige davantage d'eau, cette ressource limitée doit également répondre aux besoins de toutes les autres formes de vie sur la terre. La rareté de l'eau douce et son emploi inconsidéré compromettent de plus en plus la possibilité d'un développement durable.

Le stress hydrique et très répandu dans le monde affectant ainsi près du tiers des populations du globe comme l'indique l'image ci-dessous.




Et pourtant des régions comme l'Afrique semblent disposer de ressources en quantités très importantes comme l'indique la carte ci-dessous. Le continent africain dispose de grands fleuves comme le Congo, le Nil, le Zambèze, le Niger, le Limpopo, l'Orange, le Sénégal, mais aussi de grandes réserves d'eaux souterraines du lac Victoria, par example, le deuxième plus vaste au monde. Mais selon WWF (2002), l'Afrique est le deuxième continent le plus sec après l'Australie, et des millions d'africains subissent des pénuries d'eau tout au long de l'année.




***Sources d'eau en Afrique***

## 1.4 Eau et changements climatiques

Les changements climatiques prévus pour les décennies à venir auront des effets variés sur les ressources en eau. Les modifications de plus en plus extrêmes dans la variation dans le temps et dans le volume des précipitations ont un impact considérable sur la planète. La plupart des scénarios prévoient une augmentation des débits annuels moyens des cours d'eau aux latitudes élevées et en Asie du Sud-Est et une diminution de ces débits en Asie centrale, dans le bassin méditerranéen, en Afrique australe et en Australie. La population vivant dans des régions exposées au stress hydrique devrait donc augmenter.

Les inondations pourraient augmenter d'ampleur et de fréquence dans beaucoup de régions du fait de la fréquence accrue des épisodes de fortes précipitations, qui peuvent accroître l'écoulement dans la plupart des zones et faciliter la recharge des nappes souterraines dans certaines plaines inondables. Les changements d'affectation des terres pourraient accentuer ces phénomènes. Pendant les périodes de basses eaux, le débit des cours d'eau devrait diminuer dans de nombreuses régions en raison d'une évaporation accrue, dont les effets pourraient être amplifiés ou neutralisés par les modifications de la pluviosité. Le changement climatique projeté devrait en outre contribuer à diminuer la qualité des ressources en eau en élevant leur température et en augmentant la charge polluante provenant des écoulements et des débordements des installations de traitement des déchets. Alors que la réduction des débits devrait encore accentuer cette perte de qualité, leur augmentation pourrait cependant atténuer, dans une certaine mesure, la dégradation de certaines ressources en eau en favorisant la dilution.

En Afrique de l'Ouest comme l'illustre le projet AMMA (2002) sur la variabilité de la Mousson Africaine de l'Ouest (MAO), le passage –aux conséquences dramatiques– de conditions humides (dans les années 50 et 60) à des conditions beaucoup plus sèches (dans les années 70 à 90) sur tout le Sahel représente un des signaux inter-décennaux les plus forts observés sur la planète au 20ème siècle. Superposé à ce signal, les variations interannuelles marquées des décennies récentes ont eu comme conséquence des années extrêmement sèches, aggravant l'impact environnemental et socio-économique du déficit d'ensemble. Une telle variabilité soulève des questions importantes pour le développement durable de toute la région, notamment pour ce qui concerne la dégradation des terres et la sécurité alimentaire.

Un gros effort reste à consentir pour une meilleure connaissance de la mousson africaine de l'ouest qui joue un rôle important dans le système climatique mondial.

## 1.5 Les usages de l'eau

### 1.5.1 Eau et agriculture

L'agriculture est de loin le plus grand consommateur d'eau dans toutes les régions du monde, puisque 69 pour cent des prélèvements mondiaux lui sont imputables, dont la moitié sont gaspillées. En Afrique, on estime que 88 % de l'eau douce sert à l'agriculture, tandis qu'en Inde 90% de l'eau est destinée à cette activité. L'irrigation est l'activité qui consomme le plus d'eau. Bien trop souvent, ces pratiques agricoles ont été mal planifiées et n'ont pas apporté les bénéfices qu'on en attendait pour les populations pauvres. Inévitablement une utilisation aussi intensive de l'eau pour l'agriculture fragilise les disponibilités en eau.

La plupart des systèmes d'irrigation en Afrique gaspillent de l'eau. En règle générale, entre 35 % et 50 % seulement de l'eau retirée pour irriguer l'agriculture parvient aux cultures. La plus grande partie s'infiltre dans des canaux dépourvus de revêtement, s'échappe par des fuites de conduites ou s'évapore avant d'arriver dans les champs. Bien qu'une partie de l'eau «perdue» par des systèmes d'irrigation peu efficaces revienne aux cours d'eau ou aux nappes souterraines, d'où on peut la récupérer, la qualité de l'eau est invariablement dégradée par les pesticides, les engrais et les sels qu'entraîne le ruissellement. Des systèmes d'irrigation médiocrement organisés et aménagés ont limité les rendements sur la moitié des terres irriguées.
Devant la situation de déficit que subit la planète, l'usage de méthodes alternatives est nécessaire. A travers les méthodes traditionnelles de collecte des eaux pluviales, l'irrigation goutte à goutte et l'application judicieuse des informations météorologiques et climatiques, on peut réduire les pertes d'eau à ce niveau.

### 1.5.2 Approvisionnement en eau potable

L'eau est un facteur déterminant du développement des nations et des hommes. Mais la terre est caractérisée par un taux de croissance démographique très élevé surtout dans les régions pauvres où la ressource en eau est peu abondante. De ce fait les ressources renouvelables disponibles en eau par habitant y sont progressivement en baisse, ainsi dans le Proche et le Moyen Orient les ressources disponibles ont chuté de 3 300 mètres cubes par habitant et par an ($m^3$/h/an) en 1960, à 1250 $m^3$/h/an en 1996, et devraient atteindre les 725 $m^3$/h/an d'ici 2025. Cependant plusieurs pays de la région se trouvent déjà bien en dessous du seuil de 500 $m^3$/h/an. Dans presque tous les pays du tiers monde, la demande en eau dépasse déjà les apports annuels en ressources renouvelables.

Le niveau de référence de 1 000 $m^3$/h/an un indicateur de la rareté de l'eau ; en dessous de ce niveau, le pays souffre vraisemblablement d'une pénurie chronique d'eau assez grave pour entraver le développement et affecter la santé humaine; le niveau inférieur à 500 $m^3$/h/an correspondant au stress hydrique grave est assez fréquent dans les pays sous-développés notamment en Afrique.

### 1.5.3 Eau et environnement

Au niveau mondial une crise de l'eau menace toute la planète à travers la sécurité, la stabilité et la viabilité de l'environnement de tous les pays. Les grands écosystèmes de la terre sont majoritairement tributaires des ressources hydriques, ainsi par exemple au siècle dernier, on estime que plus de la moitié des zones humides de la planète ont disparu essentiellement par suite des activités humaines.

Ces hydro-systèmes constituent pourtant des milieux naturels primordiaux dont les fonctions et les avantages sont maintenant bien identifiés et largement reconnus.

Une proportion importante de l'eau douce qu'offre le cycle hydrologique doit être réservée à la survie des écosystèmes aquatiques naturels –marais, cours d'eau, terres humides côtières– et des millions d'espèces qu'ils abritent. De bons écosystèmes naturels sont les régulateurs indispensables de la qualité et de la quantité de l'eau. Par exemple, les plaines humides inondées par des crues absorbent et entreposent l'eau quand les cours d'eau débordent, réduisant ainsi les dégâts causés en aval.
Dans la quasi-totalité des régions du monde, l'utilisation inconsidérée des ressources en eau porte tort à l'environnement naturel. Dans l'ensemble du monde, plus de 20 % de toutes les espèces de poissons d'eau douce sont en danger ou vulnérables, ou viennent d'être déclarées disparues. Comme le prouvent de nombreux exemples, la surexploitation et la mauvaise utilisation des ressources en eau douce entraînent de graves conséquences pour les espèces naturelles et pour les populations humaines.

Partout dans le monde, on constate une baisse de la qualité de l'eau et des réserves disponibles. Environ 75% de la population rurale et 20% de la population urbaine mondiale ne bénéficient pas d'un accès direct à de l'eau non contaminée.

Au cours des dernières années les phénomènes de pollution des eaux ne cessent de s'aggraver et dans plusieurs régions la situation tend vers la crise. Deux grands facteurs de pollution des eaux renouvelables sont indexés :

– La pollution d'origine agricole prend des dimensions inquiétantes.
  Dans de nombreuses régions agricoles ou d'élevage intensif, les réserves d'eau souterraines sont contaminées par des nitrates provenant soit d'un excès d'engrais azotés, soit du lisier des animaux domestiques, vaches et porcs.

  Le drainage des eaux qui ont servi à l'irrigation est très mal assuré. Ces eaux de drainage fortement chargées de nitrates et de sels divers polluent les nappes phréatiques. Les normes de l'Organisation mondiale de la santé (OMS), qui exigent que l'eau potable renferme moins de 40 mg de nitrates par litre, ne sont pas respectées dans beaucoup de pays.

– les effluents urbains et industriels sont partout à l'origine d'une importante dégradation. Une fraction importante de la population mondiale urbaine n'est pas reliée à un réseau d'assainissement. Quand il y a un réseau d'assainissement, les eaux sont rarement traitées et les effluents urbains et industriels se déversent directement dans les rivières où envahissent les nappes qui servent à l'irrigation ou à l'alimentation domestique.

La réutilisation des eaux usées pour l'irrigation est une pratique ancienne qui peut être remise au goût du jour. Cette réutilisation constitue un élément essentiel de la stratégie de gestion de la demande parce qu'elle conserve l'eau.

### 1.5.4 Eau et santé publique, sécurité alimentaire et développement urbain

La santé de l'homme dépend d'un approvisionnement fiable en eau saine et de conditions correctes d'hygiène. Un cinquième de la population mondiale ne dispose pas d'eau potable saine et quelques 2, 4 milliards n'ont pas d'installations sanitaires ce qui pose un véritable problème de santé publique à l'échelle mondiale. Le problème est grave dans les pays en voie de développement. On estime qu'à tout moment, la moitié environ des habitants des pays en voie de développement souffrent d'affections liées à l'eau dues directement à des infections ou indirectement à des organismes vecteurs de maladies tels que les moustiques. Les diarrhées, les infections par les vers parasites, l'onchocercose et le paludisme sont parmi les plus courantes de ces affections. Ainsi, en Afrique par exemple le manque d'accès à l'eau potable et à des moyens d'assainissement adéquats se traduit par des centaines de millions d'épidémies d'origine hydrique et par plusieurs millions de décès par an, ce qui ne manque d'impliquer d'importantes répercussions défavorables sur la productivité économique surtout dans les pays en développement.

La tendance, dans les dernières décennies, dans beaucoup de régions du monde a été un accroissement de la population un peu supérieur à l'accroissement de la production vivrière. L'irrigation a apporté une importante contribution à la production agricole, mais des ouvrages d'irrigation inefficaces peuvent aboutir à un engorgement hydrique, à la salinisation et à l'alcalisation des sols. Ainsi durant les années 80 on estime qu'environ 10 millions d'hectares de terres irriguées ont dû être abandonnés chaque année, suite à une mauvaise gestion de l'eau et des espaces.

La pauvreté figure parmi les facteurs qui expliquent la dégradation de l'environnement. Dans les villes, les citadins pauvres, qui sont incapables d'obtenir des ressources, trop rares, ou de se protéger des atteintes portées à l'environnement, sont ceux qui souffrent le plus des conséquences négatives de l'environnement. On estime qu'un quart de la population urbanisée vit en dessous du seuil de pauvreté et ce sont les ménages dirigés par des femmes qui sont les plus touchés. Ainsi en ville comme en milieu rural l'accès à l'eau est un élément important pour l'évaluation du niveau de vie des populations.

La moitié environ de la population mondiale vit aujourd'hui en milieu urbain. La majorité de cette population citadine vivant dans des villes d'Afrique, d'Asie et d'Amérique latine.

Aujourd'hui à côté de l'irrigation des terres agricoles la consommation d'eau urbaine pose de grave problème car elle vient compliquer la tâche d'une gestion durable de la ressource. Ainsi les besoins en eau des villes ont augmenté très fortement par la combinaison de plusieurs facteurs que sont par exemple: la croissance des effectifs urbains, l'amélioration du niveau de vie, l'amélioration des conditions sanitaires, les besoins d'eau liés à l'industrialisation qui ont beaucoup progressé, les consommations liées au développement de l'activité touristique.

La vulnérabilité des sociétés suite à une mauvaise gestion des ressources en eau est un problème crucial dans les pays en voie de développement. Il ne fait pas de doute qu'il est indispensable, pour changer la situation de renforcer l'éducation et la sensibilisation des jeunes et des femmes. Pour ces dernières il faut aussi penser à améliorer les conditions surtout par rapport aux taches ayant trait à la recherche et au transport de l'eau qui leur sont très souvent dévolues dans des régions comme l'Afrique.

### 1.5.5 Les catastrophes liées à l'eau

L'idée d'un climat agressif s'impose de plus en plus dans un monde où les catastrophes ont pour nom les sécheresses, Tsunami, ouragan, cyclones, typhon, inondation, glissement de terrain etc. L'augmentation du nombre de ces manifestations liées à l'eau est attribuable aux modifications générales du climat de la terre.

## 2.0 LES PRINCIPES DIRECTEURS ET DEFINITIONS DE LA GIRE

- Principe No. 1 - L'eau douce - ressource fragile et non renouvelable – est indispensable à la vie, au développement et à l'environnement. Comme l'eau est indispensable à la vie, la bonne gestion des ressources exige une approche globale qui concilie développement socio-économique et protection des écosystèmes naturels. Une gestion efficace intégrera l'utilisation du sol et de l'eau pour la totalité d'un bassin versant ou d'un aquifère.
- Principe No. 2 - La gestion et la mise en valeur des ressources en eau doivent associer usagers, planificateurs et décideurs à tous les échelons. Pour ce faire, il faut que les décideurs, comme l'ensemble de la population, soient bien conscients de l'importance des ressources en eau. Les décisions seraient donc prises à l'échelon compétent le plus bas en accord avec l'opinion publique et en associant les usagers à la planification et à l'exécution des projets relatifs à l'eau.
- Principe No 3 - Les femmes jouent un rôle essentiel dans l'approvisionnement, la gestion et la préservation de l'eau. Les arrangements institutionnels relatifs à la mise en valeur et à la gestion des ressources en eau tiennent rarement compte du rôle primordial des femmes comme utilisatrices d'eau et gardiennes du milieu vivant. L'adoption et l'application de ce principe exigent que l'on s'intéresse aux besoins particuliers des femmes et qu'on leur donne les moyens et le pouvoir de participer, à tous les niveaux, aux programmes conduits dans le domaine de l'eau, y compris la prise de décisions et la mise en œuvre, selon les modalités qu'elles définiront elles-mêmes.
- Principe No 4 - L'eau, utilisée à de multiples fins, a une valeur économique et devrait donc être reconnue comme bien économique. En vertu de ce principe, il est primordial de reconnaître le droit fondamental de l'homme à une eau salubre et à une hygiène adéquate pour un prix abordable. La valeur économique de l'eau a été longtemps méconnue, ce qui a conduit à gaspiller la ressource et à l'exploiter au mépris de l'environnement. Considérer l'eau comme un bien économique et la gérer en conséquence, c'est ouvrir la voie à une utilisation efficace et équitable de cette ressource, à sa préservation et à sa protection.

### 2.1 Les différentes définitions de la GIRE

Plusieurs définitions de ce concept sont proposées:

- La GIRE est un processus qui encourage la mise en valeur et la gestion coordonnée de l'eau, des terres et des ressources associées en vue de maximiser le bien-être économique et social qui en résulte d'une manière équitable, sans compromettre la durabilité d'écosystèmes vitaux (CEDEAO 2007)
- La GIRE est un processus d'attribution de fonctions à des systèmes d'eau, l'établissement de normes, la mise en vigueur (surveillance) et la gestion. Elle comprend la collecte de données, l'analyse de processus physiques et

socioéconomiques, la considération des différents intérêts et la prise de décisions par rapport à la disponibilité, l'exploitation et l'usage des ressources en eau (Hofwegen et Jaspers, 1999).

- La GIRE est une question de planification et de gestion coordonnées des terres, de l'eau et d'autres ressources naturelles en vue de leur utilisation équitable, efficace et durable (Calder, 1999).
- D'après la déclaration de Dublin de 1972, une gestion efficace de la ressource en eau passe nécessairement par une analyse quantitative et qualitative des éléments du cycle de l'eau et la mesure des autres paramètres environnementaux qui influent sur la ressource. Ceci revient à voir si les potentialités hydriques planétaires sont suffisantes.

## 2.2 Gouvernance des ressources en eau : Problématiques et enjeux pour le XXIe siècle

Les inégalités d'accès à l'eau potable, l'eau productive et à l'assainissement, la place et l'implication du citoyen dans les prises de décision et la participation des usagers à la gestion de l'eau sont autant d'enjeux, de problématiques et de réflexion pour la définition d'une véritable politique de l'eau.

Selon divers auteurs, notamment M. Bied-Charreton, R. Makkaoui, O.Petit et M. Requier-Desjardins (2002) «la gouvernance des ressources en eau dans les pays en développement constitue un enjeu politique, économique et social prioritaires pour la prise en charge des questions d'eau au cours du XXI ère siècle». Les problèmes actuels posés par la gouvernance des ressources en eau dans les pays en développement illustrent l'échec des régulations publique et marchande dans la gestion des ressources hydriques; d'où la nécessité de les réviser et de les harmoniser aux contextes sociaux, politiques et culturels actuels.

Pour un équilibre entre une utilisation de l'eau en tant que fondement pour la subsistance de l'espèce humaine sur terre et sa conservation en vue de garantir la pérennité de ses fonctions et caractéristiques, on fait désormais une plus grande place à la gestion intégrée des ressources en eau, qui tient compte de tous les acteurs dans la planification, la mise en valeur et la gestion de l'eau.

La gestion intégrée des ressources en eau est un processus qui favorise le développement et la gestion coordonné de l'eau, des terres et des ressources connexes, en vue de maximiser, de manière équitable, le bien-être économique et social qui en résulte, sans pour autant compromettre la pérennité d'écosystèmes vitaux.

Ainsi, la gestion intégrée des ressources en eau devrait se pencher sur tous les problèmes de gestion de l'eau, à leurs interactions, et ce, tout en ayant pour but ultime de promouvoir l'équité, l'efficacité et la durabilité à travers la participation communautaire à la gestion de l'eau ; la gestion des eaux continentales et la détermination de politiques au niveau national.

### 2.2.1 Géopolitique de l'eau / Bassins transfrontaliers / Bassins côtiers

Plus indispensable à la vie que le pétrole, le problème de l'eau douce et de son partage pèse sur la géopolitique au vu des nombreux hydro-conflits (Sénégal-Mauritanie, Moyen-Orient etc.). Près de 300 bassins hydrographiques dans le monde sont partagés entre plusieurs nations. Le partage de l'eau est souvent source de conflits. Le partage concerne aussi bien des eaux superficielles que souterraines. Les enjeux sociaux, économiques et géopolitiques actuels incitent à une prise en charge rationnelle et durable de leur gestion.

Dans ce cadre, un accent particulier doit être mis sur l'importance de la gouvernance locale et nationale de ces ressources. A travers les bassins transfrontaliers, l'eau est de plus en plus perçue comme un bien public mondial, une coopération internationale autour de ces enjeux met en évidence l'interdépendance entre les gouvernances nationale et supranationale pour la gestion de ce bien commun.

Une dynamique actuelle autour des grands bassins veut transformer les conflits potentiels par une coopération effective à travers une meilleure gestion de cette ressource. Les grands bassins fluviaux font l'objet de relations complexes entre pays riverains et le partage des ressources en eau est potentiellement une source de conflits. L'eau peut servir à asseoir une solide coopération, et des exemples existent pour illustrer ce cas à travers le lac Titicaca (entre la Bolivie et le Pérou) qui se partagent les communautés paysannes des Andes pour l'irrigation ou le bassin du fleuve Sénégal qui se partage sans trop de heurts le Mali, la Guinée, la Mauritanie et le Sénégal.

**2.2.2 L'eau dans le cadre du développement durable**

L'eau est un des éléments essentiels pour le développement durable. La disponibilité d'une eau douce pure et saine conditionne l'avenir de l'homme et, au-delà, celui de la biosphère tout entière.

La situation préoccupante de la gestion de l'eau est mondialement partagée, c'est pourquoi les questions d'eau sont inscrites dans toutes les stratégies internationales de développement. Ainsi, une prise de conscience de la communauté internationale tout entière, de l'impérieuse nécessité de gérer autrement les ressources naturelles de la planète terre, au risque de déboucher sur une impasse grave pouvant hypothéquer la survie même de l'espèce humaine.

Déjà au sortir de la conférence de Dublin en 1992, le principe était retenu que l'eau est un bien commun et un bien économique dont la gestion doit être participative et intégrée où les femmes joueront un rôle de première importance. Ces principes ont été rappelés dans les dispositions du chapitre 18 de l'agenda 21 suite à la conférence de Rio (1992)

L'eau et l'assainissement sont au cœur de toutes les préoccupations qui motivent les Objectifs du Millénaire pour le Développement. Ainsi, dans l'objectif 7 consistant à assurer la pérennité de l'environnement, les dirigeants des pays du monde ont convenu *de réduire de moitié, au plus tard en 2015, la proportion d'individus qui n'ont pas accès à l'eau potable ou n'ont pas les moyens de s'en procurer*. Au Sommet mondial pour le développement durable (SMDD) qui s'est tenu à Johannesburg en 2002, un objectif complémentaire a été fixé, à savoir: *réduire de moitié, dans le même délai, la proportion d'individus qui n'ont pas accès aux services d'assainissement de base*. Enfin, il a été retenu récemment en mars 2003 à la conférence mondiale sur l'eau de Kyoto, *l'élaboration de plans d'actions nationaux de gestion intégrée des ressources en eau à l'horizon 2015*.

### 2.2.4 Le Financement de l'eau

L'accès à l'eau est reconnu comme un droit humain fondamental, mais sa caractéristique de facteur de production et de valeur économique lui confère aussi un prix. Ainsi, il est indispensable de recouvrir le coût de la fourniture de l'eau à la population dans la mesure où on en gère le bon fonctionnement. La privatisation de ce service est au cœur de plusierus discussions. Mais toujours est-il que le principe juridique selon lequel cette ressource, considérée comme un bien naturel, gratuit, inépuisable, est un bien public commun est fermement maintenu et réaffirmé.

Cette question du prix de l'eau pose de nouveau le débat sur la différence d'accès entre les couches sociales même si des solutions compensatoires sont en train d'être trouvées. Au Sénégal, le coût de l'eau est très élevé pour les couches sociales les plus défavorisées. Il varie de 100 F à 120 F/m$^3$ en milieu rural à 500-600 F/m$^3$ en milieu urbain.

Cependant, il est toujours prioritaire de renforcer l'assise institutionnelle et financière du secteur en vue de poser les solutions d'une croissance plus équilibrée.

Les revenus sont très bas dans la plupart des pays surtout dans ceux du tiers-monde, cette idée de créer en fait un marché de l'eau pose un vrai débat et certains auteurs considèrent l'impôt sur l'eau irréaliste. Donner un prix à l'eau ne peut avoir qu'un effet limité – il est difficile de résoudre les problèmes de l'eau par les lois du marché. L'eau a surtout une valeur d'usage qui dépend de son mode d'utilisation. Le marché ne peut vraiment jouer que pour l'eau potable qui ne représente qu'une proportion réduite de l'eau consommée. L'irrigation suppose de l'eau à faible coût et en grande quantité. Des ajustements tarifaires ont été tentés surtout pour la consommation urbaine, ils sont beaucoup plus difficiles à imposer pour l'eau d'irrigation qui reste souvent gratuite ou bien facturée à un coût bien inférieur à son prix de revient.

Les grandes interrogations à ce propos concernent la recherche de ressources financières nécessaires pour atteindre les deux Objectifs de développement du Millénaire concernant l'eau et l'assainissement.

## 2.3 Méthodes et outils de mise en œuvre

Il existe une grande variété d'instruments et de méthodes, pouvant être utilisés en fonction de la visée et de l'échelle de la gestion intégrée.

Généralement le développement d'un cycle de GIRE peut comprendre les étapes suivantes (OMM, 2006):

- Elaboration du portrait des ressources en eau
- L'établissement d'un diagnostic relativement aux ressources en eau
- La définition d'une vision à long terme et moyen terme
- L'élaboration d'un plan d'action
- Le suivi, l'évaluation et la mise à jour du plan

Un certain nombre de méthodes et d'instruments remarquables sont brièvement présentés ci-dessous:

| + le plus utile | O le moin utile |
|---|---|

| les phases du processus de planification<br><br>**OUTILS** | **Démarrage** | **Analyse** | **Conflits et opportunités** | **Objectifs** | **Stratégie** | **Mise en œuvre** | **Suivi et évaluation** |
|---|---|---|---|---|---|---|---|
| Recueil de données | + | + | | | | | |
| Utilisation des données | | + | O | | | | + |
| Base de données | | + | | | | | O |
| SAD[2] | | + | + | O | + | | + |
| Scénarios | | + | + | O | + | | O |
| Réglementation | | | | | + | + | O |
| Zonage | | | | | + | + | O |
| Instruments économiques | | | | | + | + | O |
| Sensibilisation | O | | | | + | + | O |
| EIE[3] | | | | | | + | + |
| ESE[4] | | + | + | | | | + |
| Evaluation économique | | + | + | | | | + |
| Analyse des risques | O | + | | | | | + |
| Résolution des conflits | + | | | + | | + | + |

[2] Les **systèmes d'aide à la décision (SAD)** sont un élément indispensable au processus de décision. Les **SAD** classiques utilisent la méthode appelée "optimisation sous contrainte"

[3] Etude d'impact Environnemental

[4] Evaluation stratégique environnementale

## 3.0 EXERCICE: LE LAC DE GUIERS

Le lac de Guiers est un exemple intéressant à approfondir pour sa situation géographique et ses multiples fonctions dans la région. Après avoir lu l'introduction des caractéristiques et des problématiques du lac ci-dessous, les élèves seront tenus à développer un plan de gestion intégré du lac de Guiers à l'aide des informations reçues en cours. Il s'en suivra une discussion sur les problèmes et/ou opportunités de la mise en œuvre de la GIRE.

### 3.1 Description


Situé à proximité de la frontière avec la Mauritanie, à environ 10 Km au sud-ouest de Richard-Toll, le lac de Guiers est la plus grande réserve d'eau douce du pays. Orienté sur un axe nord-sud, il occupe une vaste dépression naturelle longue de 50 Km sur 8 Km de large. Le plan d'eau s'inscrit dans un quadrilatère compris entre 15° 25' et 16° de longitude Ouest et 15° 40' et 16° 25 de latitude Nord. Avec une superficie de 350 Km2 et une profondeur variant de 4 à 8 m en fonction des zones et des saisons, le volume de la retenue est d'environ 400 millions de m3.

Dans sa configuration actuelle, le lac se divise en deux grands secteurs :

- Une partie nord longue de 30 Km environ et large de 5 à 7 Km, vaste nappe d'eau libre représentant plus de 80% du volume total du lac;
- Une partie Sud longue de 20 Km environ, étroite, encaissée et parsemée d'îlots plus ou moins apparents selon la hauteur du plan d'eau.

Le lac bénéficie des bonnes conditions hydrologiques par le fleuve Sénégal, lui-même régulé par deux barrages: Diama en aval et Manatali en amont. Diama (1985), situé à une trentaine de kilomètres de l'embouchure, empêche la remontée du biseau salé, alors que Manantali (1988) construit sur le Bafing, affluent du fleuve Sénégal en territoire Malien, contrôle 60%

du régime du fleuve en amont. Enfin, le pont-barrage de Richard-Toll (1947) contrôle les fluctuations du lac, tout en assurant la permanence de la ressource en eau.

L'environnement semi-désertique du lac est typique de la région écologique sahélienne caractérisée par une alternance de saison pluvieuse et de saison sèche. Cependant, la pluviométrie y est faible et irrégulière (moins de 400 mm par an) et la moyenne des températures annuelles élevées (35°C).

Le relief se compose de dunes, de vallées et de plateaux. La végétation est dominée par un tapis herbacé parsemé d'arbustes.

Sept communautés rurales et près de 300 villages se répartissent autour du lac. Sa population est estimée à plus de 150 000 habitants. Hormis les peuplements traditionnels du delta (Wolofs, Peuls, Maures), cette zone accueille une main-d'œuvre de différentes origines, Sérère, Diola, mandingue, etc. en raison des nombreuses activités économiques qui se sont développées dans la région.

Très convoité, le lac de Guiers suscite de fréquents conflits d'usage et litiges fonciers. Soumis à une forte pression anthropique dans sa moitié nord, l'équilibre écologique du lac est menacé par les pollutions industrielles et agricoles, les plantes aquatiques envahissantes. Il est également à l'origine de maladies hydriques comme la bilharziose.

### 3.1.1 Situation économique

Les rives du lac de Guiers sont aujourd'hui très convoitées à cause des différentes activités qui s'y développent: agriculture, élevage, pêche, traitement des eaux, chasse, tourisme, etc. La pluralité de ces activités, liée à la diversité des ressources, soulève une problématique propre aux zones humides, qui sont des écosystèmes à fortes potentialités, mais dont la fragilité exige une protection, surtout dans les régions situées sur le front de la désertification. Dans ce même ordre d'idée, l'établissement de stratégies de protection des ressources naturelles, en vue d'un usage durable, est un enjeu important non seulement pour les générations présentes, mais aussi et surtout pour celles à venir.

Cependant, les potentialités sont encore sous-exploitées et les revenus annuels des populations restent très faibles. Mais la création de l’Aire du Patrimoine Interrégional du lac de Guiers et ses mesures d’accompagnement devraient permettre leur développement en harmonie avec le milieu dont leur avenir dépend.

Les enjeux socio-économiques sont partagés par deux régions administratives (Saint Louis au nord et Louga au sud) et sept communautés rurales: Ronkh, Gnith, Mbane (région de Saint Louis) et celles de Keur Momar Sarr, Nguer Malal, Gandé et Syère (région de Louga) qui présentent des intérêts communs autour de la gestion des ressources et de l’espace du lac.

Ainsi, la gestion collective de la ressource devient un enjeu de taille et une question sensible qu’il faudrait aborder dans un contexte de participation à tous les niveaux avec tous les acteurs.

### 3.1.2 Les problèmes

Le Lac de Guiers est aujourd'hui agressé par l'accélération du processus d'aménagement agricole des rives, la multiplication des formes d'usage de l'eau (alimentation en eau potable, irrigation, drainage), les rejets toxiques, la prolifération des plantes aquatiques.

La construction des barrages a amélioré les hauteurs d'eau et facilité l'irrigation, mais ils ont également provoqué d'importantes perturbations dans le milieu naturel.

La démographie galopante, l'urbanisation rapide, une pauvreté croissante et une faible productivité de l'agriculture ont des répercussions néfastes sur les ressources du lac.

Le développement de la culture irriguée dans l'ensemble de la vallée du fleuve Sénégal a un impact sur l'évolution de la qualité des eaux du lac de Guiers.

La pollution chimique et microbiologique du Lac de Guiers est un bon exemple de l'évolution récente de ces phénomènes environnementaux. En l'espace de trois ans, les quantités résiduelles de sel dans le lac de Guiers ont été multipliées par trois. Le Ferlo joue un rôle important dans la gestion du lac en permettant l'évacuation d'une quantité importante de sel, mais l'insuffisance de l'approvisionnement en eau potable et de l'assainissement des villages riverains est par ailleurs à l'origine de la pollution microbiologique des eaux.

Il résulte de cette situation une altération de la qualité de l'eau, l'augmentation de la salinité dans le Bas-Ferlo, la multiplication d'algues cyanophycées, une prolifération excessive de la végétation, ainsi qu'un risque de pollution biologique et chimique.

Aujourd'hui, l'opinion publique a pris conscience des menaces qui pèsent sur le lac de Guiers, mais beaucoup de personnes ne pensent pas que le développement économique et social peut passer selon d'autres schémas que ceux de l'agriculture industrielle irriguée qui prévaut encore. La création de l'Aire du Patrimoine Interrégional du lac de Guiers peut conduire vers d'autres options qui, en exploitant judicieusement le patrimoine naturel, historique et culturel le sauvegarderaient.

### 3.1.3 Les multiples patrimoines du lac de Guiers

Par le seul volume d'eau douce qu'il contient, le lac de Guiers constitue déjà le patrimoine le plus précieux pour les communautés riveraines, les régions administratives dont il dépend et même, depuis quelques décennies, un large secteur du pays.

*Le patrimoine vivant*

La prolifération des typhas et d'autres plantes adventices envahissantes ont fait oublier la diversité de la flore palustre du lac. Certaines espèces présentent cependant un intérêt certain pour leurs vertus médicinales ou, plus simplement, l'alimentation du bétail. C'est notamment le cas d'une renouée (Polygonum sp.) une plante envahissante qui, récoltée, s'avère plus utile que nuisible car elle constitue un excellent fourrage en saison sèche. Il en est de même de l'azolle (Azolla sp.) une minuscule fougère aquatique dont la prolifération forme de vastes nappes à la surface de l'eau. Fixatrice d'azote, elle constitue un engrais naturel abondant et gratuit.

De même, la faune aquatique du lac est peut-être plus riche que ce que l'on en sait jusqu'à présent. Une trentaine d'espèces de poissons est souvent citée. Mais, par recoupements de différentes études, il en existerait une bonne cinquantaine, voire davantage. La survivance du lamantin est également incertaine, alors qu'il pourrait devenir l'animal emblématique du lac. Quant aux mollusques, crustacés, insectes, reptiles et amphibiens, aucun inventaire détaillé n'en a été encore établi.

*Les ailes du patrimoine*

Tous les plans d'eau du bas delta accueillent des centaines de milliers d'oiseaux dont un grand nombre de migrateurs qui s'y rassemblent après et avant leur traversée du Sahara. C'est à leur égard qu'ont été créés les parcs nationaux du Diawling, en Mauritanie, et du Djoudj situé à moins d'une heure de vol du lac de Guiers, ainsi que le classement du site Ramsar d'importance internationale et du Ndiael qui est son annexe. Lorsqu'il s'agit de protection des oiseaux, les chasseurs et les écologistes sont accusés de vouloir privilégier leurs intérêts au détriment de ceux des hommes. Pourtant, leur abondance indique que le milieu est d'autant plus riche qu'ils sont nombreux et la diversité des espèces montre que chaque espèce y trouve son compte sans concurrencer les autres. Or ce qui profite aux unes et aux autres profite également aux hommes. Ainsi, au Ghana, des colonies lacustres de nidification ont été favorisées afin d'accroître les produits de la pêche.

*Le patrimoine historique*

L'histoire du lac est dominée par celle de Ndaté Yalla, unique rescapée du martyr des femmes de Nder et dernière souveraine du royaume du Waalo. Sa résistance à l'occupation française, puis celle de son fils Sydya, en ont fait l'une des grandes figures du Sénégal. Mais des siècles avant elle, d'autres femmes avaient régné sur ce royaume dont les chroniques sont particulièrement riches.

*Le patrimoine culturel*

Contrée de pêcheurs depuis des siècles, Gaé-gaé et Cubbalo conservent la mémoire d'une fabuleuse anthologie des contes et légendes relatives au lac et ses hôtes, réels ou mythiques. Mais il n'est de village wolof, peul ou maure, dont les habitants ne connaissent des lieux de mémoire, évoquant un événement du passé connu souvent d'eux seuls. Quelle que soit leur importance pour les autres ces souvenirs participent de la culture locale dans laquelle s'enracinent ces sociétés. De patientes enquêtes seront nécessaires pour les recueillir et en éditer un florilège.

*Le patrimoine ethnique*

Depuis toujours et encore aujourd'hui des populations d'ethnies très diverses viennent s'établir au bord du lac pour en exploiter les ressources halieutiques, les pâturages ou encore les terres fertiles de ses rives. Chacune conserve son identité que révèle notamment l'architecture de son habitat.

*Le patrimoine des savoirs ancestraux*

Ce patrimoine procède, à la fois, des patrimoines culturels et ethniques. Le meilleur exemple est donné par les réserves et parcs nationaux. La raison de leur classement était que ces sites possédaient une grande richesse écologique. Tous pourtant étaient habités depuis des siècles par des communautés villageoises. Or ces populations savaient comment vivre du milieu qu'elles occupaient sans le dégrader. Il existait dans la gestion de l'eau, des terres, de la pêche et de la chasse, de nombreux savoirs que les méthodes modernes ont rendus obsolètes alors qu'ils pourraient très bien être repris et actualisés.

*Le patrimoine paysager*

Le sud du lac, encore naturel, contraste fortement avec le nord profondément modifié par l'agriculture et l'industrie. Cette différence peut être valorisée par un tourisme industriel tel qu'il se pratique avec succès en Europe depuis quelques années. Des visites guidées pourraient être organisées à la CSS et son unité de production de biocarburant, ainsi qu'à l'usine de traitement des eaux de Ngnith. En revanche, le secteur sud conviendrait parfaitement à des séjours de repos, de découverte et d'échanges avec les populations.

Pris dans leur ensemble, tous ces patrimoines constituent la base sur laquelle se fondent les principes du développement durable..

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# Module 2

# WATER ALLOCATION AND DEMAND MANAGEMENT

**TITLE**

WATER ALLOCATION AND DEMAND MANGEMENT

**AUTHORS AND TEACHING PROFESSORS**

Prof. S. N. Odai, Mr. Frank Annor, Dr. S. Oduro-Kwarteng, and Dr. Kwaku Adjei

**SUMMARY OF COURSE CONTENT:**

The module has three units which will cover the following:

**Unit 1:** introduction to water resources and the hydrologic cycle; uses and importance of water resources; impact of human activities on water resources quantity and quality; integrated water resources management principles and integrated water resources management (IWRM). **Unit 2:** the purpose of water allocation; objectives and principles of water allocation; scale of water allocation within basin; uncertainty in water allocation; legal framework and water rights for water allocation; principles of transboundary water allocation; priority of water allocation between sectors; water allocation mechanisms; integrated water allocation planning and modelling; case study: water allocation in Volta river basin shared by riparian countries. **Unit 3**: water demand management including water use efficiency; public awareness and education; water demand management measures; water losses management; water demand management options modeling.

**COURSE OBJECTIVES/AIM/LEARNING OBJECTIVES**

The objectives of this training module are:

- To assist participants to appreciate the linkage between water demand and water resources availability,
- To equip participants with an in-depth knowledge and skills in order to assess water allocation and formulate and implement strategies using available techniques for effective water allocation to prevent water conflicts,
- To provide understanding of the link between water resources allocation and water demand management. Participants will be able to appreciate the importance of water management and control.

**TARGET GROUPS AND LEVEL OF TRAINING**

Managers of water resources, water utilities, policy makers, water engineers and water scientists.

**TEACHING METHODS AND DIDACTICS TO BE USED**

The method of teaching and transfer of information to participants will be in the form of: lectures, group exercises and case study analysis. Participants will present their solution to the given problems or assignments during the workshops sessions.

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# 1.0 BASIC WATER RESOURCE CONCEPTS AND PRINCIPLES

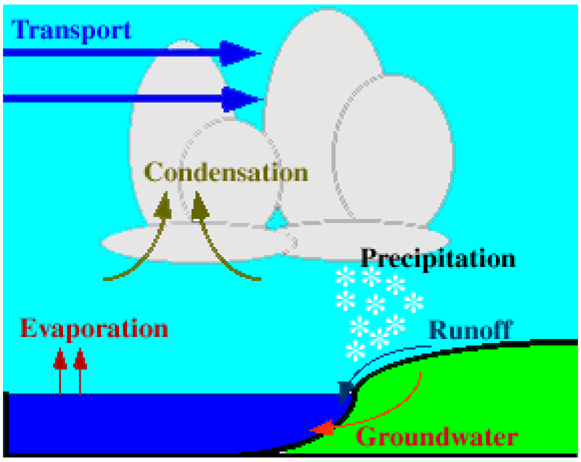
This introductory session seeks to summarize the principles of water resources management in the light of water allocation. At the end of the session participants will be able to:

- Understand water availability and water balance,
- Appreciate the uses and importance of water,
- Understand the impact on water resources,
- Appreciate the basic principles of integrated water resources management.

## 1.1 Hydrologic cycle and water resources

The main components of the hydrologic or water cycle in semi-arid environments include precipitation, evapotranspiration (evaporation and transpiration), groundwater and runoff as shown in Figure 1. The hydrologic cycle is the occurrence, circulation and distribution of water on the earth. This involves evaporation of water bodies and land, evapotranspiration from plants. This vapor is condensed into cloud droplets in the atmosphere and when it is of sufficient amount, it precipitates as rain, hail, and snow. This rain either runs as surface runoff, or percolates the subsurface as groundwater. The total water on earth remains fairly constant at all times. It only changes from one state (liquid, vapour and solid) to another depending on environmental conditions. This mass balance is key in any hydrological or water allocation model.

**Figure 1 Main components of the hydrological cycle in a semi-arid environment**




**Source: Weather World 2010**

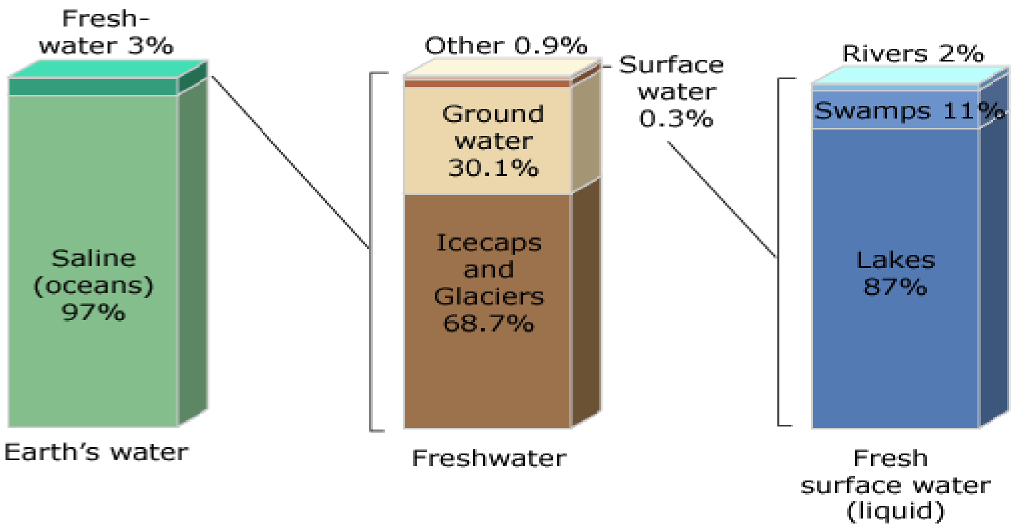
About 70% of the earth surface is covered with water. Oceans, seas, lakes, polar ice, glaciers, snow, rivers and freshwater lakes are surface water sources but water can also be found underground in aquifers and wells. There is more than enough water to meet the development requirement. However, uneven, temporal and spatial distribution of water resources prevails in several places. Shifts and extremes in the seasonal variation of rainfall pattern have aggravated the situation and created scarcity of water in many parts of the world, especially Africa. Some places are prone to recurrent drought such as Chad, Ethiopia and Malawi. Table 1 gives information about the water balance in the world and figure 2 illustrates the proportions of freshwater. Worldwide volume of water is about $1.384 \times 10^9 km^3$, out of which only 2.6% is freshwater.

**Table 1: water available in the world**

| Type | | Volume ($km^3$) | Percentage |
|---|---|---|---|
| Saline water | Oceans | 1,348,000,000 | 97.4 |
| Freshwater | Polar ice caps, icebergs, glaciers | 27,820,000 | 2.01 |
| | Groundwater, soil moisture | 8,062,000 | 0.58 |
| | Lakes and rivers | 225,000 | 0.02 |
| | Atmosphere | 13,000 | 0.001 |
| | TOTAL | 1,384,120,000 | 100 |
| | Total of freshwater. | 36,120,000 | 2.6 |

**Source: U.S. Geological Survey (2014)**

**Figure 2 illustrates the proportions of freshwater and what it constitutes.**




**Source: U.S. Geological Survey (2014)**

## 1.2 Uses and importance of water resources

Water resources as a catalyst for development cannot be overemphasized due to their uses and importance. The economic, social and cultural aspects of water resources are presented below.

1. **Economic importance**

Economic growth is the main engine for poverty reduction (development). Water resources serve as a direct impact to economic growth through agricultural and other community level income generating activities and manufacturing activities that provide employment for people. The following are some water-related economic activities:

a) **Irrigation:** This is the application of water to the soil, which is essential for sustainable plant (crop) growth.This practice ensures the food security of a nation as it increases food production, cash crops and plantation development, market values of farming implements and farm products. This contributes to a country's economic development.

b**) Navigation**: Water transportation (goods and passengers) is another important area of economic activity. Both local and international trades passing through ports enhance development of ports, coastal zones and ultimately the interior through inland waterways. Countries with navigable waters serve not only themselves but also adjoining landlocked countries. In West Africa, for example, imports for Burkina Faso are sent from Tema (Ghana) by road to Akosombo Port, and transported over Volta River with navigable length of 415km to Buipe Port where they are transported by road to Burkina Faso.

c**) Hydro-Electric Power Generation**: Water resources are used in the generation of hydro-electric power which is a very vital agent of economic activity. Without power, no production of any form can take place. Hydropower development will benefit not only the nation generating it but can also be exported to other neighbouring countries.

d) **Production and Income Generation**: Industries need water resources for their production operations, which enhance development. The fisheries sector contributes to the economic development of a nation. Water enhances economic activities such as bottled drinking water, food processing such as canneries, factory processes, industries such as pharmaceuticals and breweries, and production of fertilizers, pesticides and herbicides. Processing of agricultural products can increase their market value and/or package them for transport or export.

e). **Transboundary water co-operation**: Water resources that are shared amongst countries can enhance economic co-operation, which is an agent of regional development. Ghana has since July 1975 supplied hydropower to Togo and Benin in a joint venture. A body known as the CEB (Communante Electrifique Benin) coordinates the sharing of hydropower between these two countries, and in consequence promoting West African Cooperation and development.

f) **Domestic water supply**: Water resources for domestic consumption in homes, institutions and commercial facilities are necessary for public health, and clean water supply is the most important determinant of public health.

g) **Tourism**: Water resources, such as water falls or recreational lakes attract tourism. Examples of tourist waterfalls in Ghana include the Boti, Adom, Bui, and Kintampo falls.

Water resources are also integral to the development of parks and gardens, game and wildlife. Examples are Shai Hills and Damongo Reserves, the Aburi botanical gardens, Kakum national park.

**2. Socio-cultural Importance**

a) *Cultural*: Water resources are needed for certain cultural activities and rituals. Water is an intrinsic part of people's identities, cultures, worldviews and religious perceptions. As such, sustainable water planning should take into consideration the indigenous and other cultural water values.

b) *Religious Importance* Water resources are significant and symbolic in many religions including Christian and Muslim religions. This includes activities such as baptism and purification.

## 1.3 Impact of human activities on water resources quantity and quality

Human activities that affect our water resources' distribution, quality and quantity can include agricultural development, drainage of land surface, modifications to river valleys, and urban and industrial development. These activities contribute to the changes in the hydrologic cycle. Point sources of contamination to surface and groundwater bodies are caused by the direct effect of urban development in the form of direct discharges from sewages-treatment plants and industrial facilities. Urbanisation increases the amount of paved or concreted surfaces resulting in reduced infiltration and increased surface runoff. Deforestation also leads to increased surface runoff and reduced evapotranspiration.

Problems associated with the above mentioned human activities include: pollution of water resources, increased flooding and erosion.

In recent years, the problems of pollution from domestic, industrial and agricultural sources have been increasing, causing deterioration in water quality. Some causes of water contamination can be:

- organic matter, suspended solids and nutrient pollutants.
- waste from industrial and agricultural activities, the use of fertilizer and pesticides.
- pathogenic agents and faecal matter.

Mobile populations with river transport can bring unwelcome or exotic aquatic weeds which cover the water surface and reducing the amount of dissolved oxygen. This can impact on freshwater biota such as fish and hence cause economic loss for a local fishing industry.

Water pollution encourages the growth of unwelcome or exotic aquatic weeds which cover the water surface thus reducing the amount of dissolved oxygen. This can impact on freshwater biota such as fish and hence cause economic loss for the fishing industry.

## 1.4 Integrated water resources management principles

The Dublin principles are mostly referred to as the guiding principles of Integrated Water Resources Management (IWRM)[5]. These are basically 4 principles presented at the Dublin summit in Rio in 1992. The principles state that:

i. Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment;
ii. Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels;
iii. Women play a central part in the provision, management and safeguarding of water;
iv. Water has an economic value in all its competing uses and should be recognized as an economic good;

It is important to bear these principles in mind when allocating scarce water resources. The first principle depicts that; the water in a catchment should be considered to be finite and should be used and allocated judiciously. The second principle suggests that, for an efficient and equitable allocation of water resources, all key stakeholders should be encouraged to participate in the decision making to help make implementation acceptable. This is vital in water allocation since whatever decision that is taken has a cost and a benefit. This needs to be carefully weighed so that the resource is put to the best use. It is sometimes quite challenging to do the valuation for the various uses in monetary terms and even when done, is mostly done at the higher levels on the stakeholder ladder. Equitable water allocation must be done at the lowest level with water users and officials from government, involving both high level[6] and low level [7]stakeholders from the planning to the implementation and monitoring stages of all water related projects.

The third principle focuses on gender. For water allocation in a basin scale, this might not be a challenge but at a field scale or an irrigation scheme this is a strong issue. Women in most of sub-Saharan Africa are marginalised with regards to allocation of land. However women are involved in every step of the agriculture chain; from land preparation to marketing and this should include water allocation. This identifies women as a key stakeholder who should participate in decision-making, and also highlights the need for policies or institutional arrangement to address the needs of women for access and use of water resources.

The last principle looks at safe-guarding scarce water resources in terms of its value. This applies to both treated and raw water. This principle promotes measures to cut down on wasteful and environmentally harmful uses. It is also important to maintain lifeline access to

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[5] Refer to module 1 for more detail.

[6] High level stakeholders are the government officials from water resources commission and utility organisations

[7] Low level stakeholders are the water users and the area officials from government

domestic and irrigation water in communities. Metering of water used to check for wastage and manage distribution but it is difficult to implement this everywhere, especially for irrigation. Considering water as an economic good has its own challenges in the face of considering basic water use as a human right.

## 1.5 Applying integrated water resources management (iwrm)

The benefits of water resources can be maximized through their sustainable management. Sustainable use of water resources calls for a shift from an exclusive focus on water supply to a broader approach that incorporates multi-sector use to ensure a suitable balance between agricultural, industrial and domestic use of water as well as the protection of catchments areas.

Integrated water resources management principles include an equitable and sustainable use and management of water resources for poverty alleviation. It includes watershed and water resources management at river basin level, and the involvement of stakeholders (communities, local government and municipalities, water Agencies).

Watershed management addresses issues such as prevention of land degradation, pollution control and flood prevention. Water pollution from domestic, industrial and agricultural sources within the watershed is normally controlled by specific water agencies.

Some of the possible management measures, which can be adopted, include:

- *Waste minimization* by industries by altering the manufacturing processes so that less offensive wastes are produced. Industries can treat their effluents to a level as directed by EPA.
- *Wastewater treatment:* Treatment of domestic and other wastes before discharge into water bodies. Design of various treatment plants and processes to purify wastewater flows by primary, secondary, and tertiary treatment.
- *Upstream storage of wastewater* to augment the stream flow by releasing water only when necessary.
- *Pollution Control policies and laws*, regulating water resource must be enforced to curb the menace of pollution.

## 2.0 WATER ALLOCATION ASSESSMENT AND MODELLING

This session explains the concepts and principles of water allocation of water resources management. At the end of the session participants will be able to:

- Appreciate the purpose of Water Allocation;
- Explain the objectives and principles of Water Allocation;
- Discuss the scale and uncertainty of water allocation within basin;
- Discuss the legal frameworks and water rights systems for water allocation;
- Explain the principles of Transboundary Water Allocation;
- Explain Water Allocation between Sectors;
- Discuss the types and application of water allocation mechanisms; and

This will be supported by a case Study demonstrating the data requirements and the role that GIS and Remote sensing plays in complimenting ground-based (observed) data for water allocation modelling.

## 2.1 Definition and purpose of water allocation

**What is water allocation?**

"Water allocation is defined as sharing of water among (competing) users. The purpose of the allocation of water to different users is to match or balance the demand for water with its availability" (van der Zaag, 2010). Water allocation is not an issue when water availability surpasses the demand. In such situations all demands can be satisfied, and in fact there is no need for a regulated allocation of water. In many catchment areas and parts of river basins, however, water availability is frequently less than the demand for it. It is then necessary to find a suitable allocation of the limited water resources. Water allocation is not only concerned with the physical allocation of water. More broadly it is about satisfying conflicting interests depending on water. These may be functions derived from water such as navigation (navigability, minimum water levels), hydropower (head difference), environment (a water regime of water level fluctuation), recreation (availability of water but non-consumptive), etc. These functions are not all consumptive, but can be conflictive in their timing and spatial distribution.

A useful working definition would be that water allocation is the combination of actions which enable water users and water uses to take or to receive water for beneficial purposes according to a recognized system of rights and priorities (UNESCAP, 2000). In addition to water's time-varying characteristics and its extreme importance to humans and society, the links between climate, hydrology, the environment, society, economics and sustainable development, add to the complexity of the task.

***Aspects of water allocation***

Water allocation involves a number of aspects which are presented in Table 2 below.

**Table 2: Aspects of water allocation**

| Aspects | Description |
|---|---|
| Technical base | The monitoring, assessment and modelling of water and its behaviour, water quality and the environment |
| Legal basis | Water rights and the legal and regulatory framework for water use |
| Institutional base | Government and non-government responsibilities and agencies which promote and oversee the beneficial use of water |
| Financial and economic aspects | The determination of costs and recognition of benefits that accompany the rights to use water, facilitating the trading of water |
| Public good | The means for ensuring social, environmental and other objectives for water |
| Participation | Mechanisms for coordination among organizations and for enabling community participation in support of their interests |
| Structural and | Structural works which supply water and are operated, and the |

| | |
|---|---|
| development base | enterprises which use water |

Source: Adapted from UNESCAP (2000)

## 2.2 Objectives and principles of water allocation

The overall objective of water allocation is to maximize the benefits of water to society. However, this general objective implies other more specific objectives that can be classified as social, economic and environmental in nature as shown in Table 3. For each classification there is a corresponding principle: equity, efficiency and sustainability, respectively.

**Table 3: Objectives and principles of water allocation**

| **Objective** | **Principle** | **Outcome** |
|---|---|---|
| Social objective | Equity | Provide for essential social needs:<br>○ Clean drinking water<br>○ Water for sanitation<br>○ Food security |
| Economic objective | Efficiency | Maximize economic value of production:<br>○ Agricultural and industrial development<br>○ Power generation<br>○ Regional development<br>○ Local economies |
| Environmental objective | Sustainability | Maintain environmental quality:<br>○ Maintain water quality<br>○ Support in-stream habitat and life<br>○ Aesthetic and natural values |

Source: Adapted from UNESCAP (2000)

**Equity:** Equity means the fair sharing of water resources within river basins, at the local, national, and international levels. Equity needs to be applied among current water users, among existing and future users, and between consumers of water. It is important to have pre-agreed rules or processes for the allocation of water, especially under the situations where water is scarce. Such agreements and methodologies should reflect the wishes of those affected sufficiently to be seen to be equitably and accountably applied.

**Efficiency:** Efficiency is the economic use of water resources, with particular attention paid to demand management, the financially sustainable use of water resources, and the fair compensation for water transfers at all geographical levels. Efficiency is not so easy to achieve, because the allocation of water to users relates to the physical delivery or transport of water to the demanding points of use. Many factors are involved in water transfers, one of which is the conflict with equitable water rights. For example, agriculture is often a low profit use, and so some water for irrigation will be transferred to some industrial uses if policy makers decide to achieve an efficiency-based allocation of water.

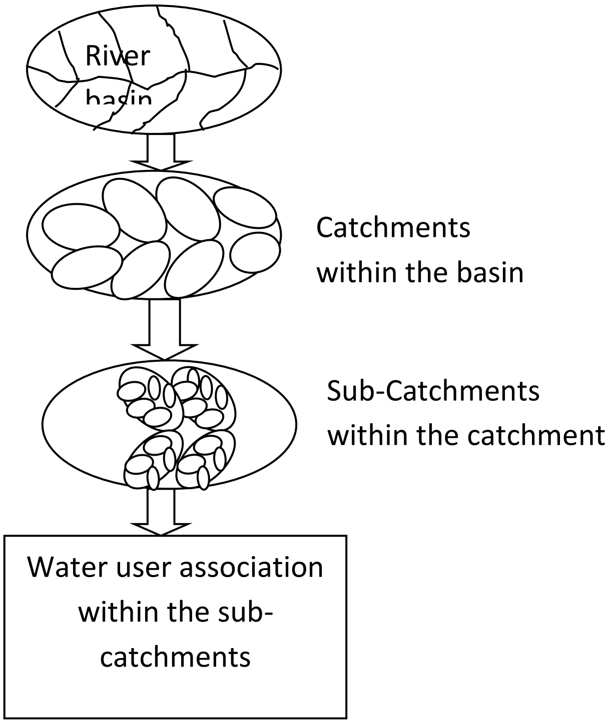
**Environmental**: Sustainability advocates for the environmentally sound use of land and water resources. This implies that a current utilization trend of water resources should not expand to such an extent that they impact on future water resources use.

## 2.3 Scale of water allocation within basin

An allocation process that does not encompass the entire river basin runs the risk of being affected by upstream uses and in turn impacting on downstream uses. Since most river basins are simply too large in area for easy management, and often shared by more than one country, the water allocation processes are fragmented into catchment areas which form part of the larger basin (see figure 3). In such cases the allocation process must include boundary conditions; i.e. a specification of water uptake and outgoing flow at the inlet and at the outlet of the catchment area under consideration. Even the farthest downstream catchment area such as an estuary will need to set such boundary conditions so as to minimise saltwater intrusion, ensure the health of the estuary for environmental quality, and address social and economic needs.

Boundary conditions are especially important in river basins that are shared by more than one country. If an upstream water allocation institution does not consider the requirements of the downstream country, it may affect the bilateral relations of the two neighbouring countries. Any allocation decision potentially has an externality as it may affect those not immediately involved in the allocation process, either beneficially or detrimentally. A special case, and a very important one, is where downstream users are affected, but they are located outside the jurisdiction of the water allocation authority.

**Figure 3: Water use and water development plans at various levels in a basin**




It would be advisable to formalise such boundary conditions in writing and to get them endorsed by all water allocation institutions involved. They should indicate how claims of individual water users are formalised in water permits or rights. The water allocation process should ideally consider both the detailed allocation decisions between individual water users at the local level, as well as allocation decisions covering the entire river basin. Obviously, these different spatial scales require different levels of accuracy and specificity. But they are both required, since decisions at these different spatial scales affect each other. In practice, the decision-making process should be iterative, with an initial focus on the smaller spatial scales, especially in heavily committed parts of a basin.

Increasing pressures on our water resources has led to a widening of the scope of the water allocation processes. It should be noted that an obligation to surrender a certain amount of water to a downstream area or country does not imply that all this water is "lost" by the upstream catchment. Catchments also need to provide for environmental water requirements within its area of jurisdiction, and water that will flow to the downstream area could first serve these environmental requirements (or at least the non-consumptive part).

The question of how much water an upstream catchment area allocates for downstream users is subject to agreements with the stakeholders involved (between sub-catchment areas along one tributary or between riparian states).

## 2.4 Uncertainty in water allocation

The allocation of water over different uses should therefore aim to effectively deal with uncertainty and increase the predictability of water available to the various uses. Increased predictability is an important condition that will allow users to use water more efficiently. Even a better understanding of how *unpredictable* water availability is will improve a user's ability to deal with this. Two types of uncertainty may be distinguished: physical uncertainty and institutional uncertainty.

*Physical uncertainty* refers to the impact of human activities on the hydrological cycle. At the global level, human-induced climate change is a possibility and may have wide-ranging effects, but the specific effects are not yet well understood. At a smaller spatial scale, the effects of land use change on the availability of water are difficult to predict. The water management agency should then put in place a programme of data collection meant to gradually improve the understanding of these dynamic processes.

*Institutional uncertainty* is created by the institutions that are involved in water allocation. If the manner in which such institutions allocate water is unknown to the users or ill-understood by them, or seen as haphazard, then users may distrust the allocation process. They will receive the wrong (perverse) incentives to, for instance, overstate their water requirements, hoard water or even over-use it. The institutional system of water allocation should therefore be predictable to users. All users should know the principles and procedures guiding the allocation of water. Moreover, the allocation process must treat all users in the same way. It must also be transparent, and information on permits granted or permits refused must be freely accessible, not only to all water users, but to the wider public as well. A fair and transparent allocation process will enhance the individual users' trust in the process, and will increase their confidence in the worth of their permits/rights to use water. Trust in the allocation process will enhance users’ willingness to invest in water related infrastructure, and desist from "free-ride behaviour" in times of water scarcity.

## 2.5 Legal framework and water rights for water allocation

In many countries, the State is the owner of all or nearly all water and allocates water permits or user rights (water rights). Water is considered a public good and is owned by the citizens of a country, and the government manages this public good on their behalf. Laws and regulations will therefore provide the rules pertaining to the use of this public resource. Balancing supply and demand must be done within the established legal framework. A country's water law and subsidiary government regulations will prescribe many aspects of water allocation.

The legal frameworks of countries cover the following:

- The law will prescribe the types of water use that are regulated and therefore require some kind of permit, concession, right etc.; and the types of water use that are not regulated and do not require permission. The use of water for primary purposes often does not require a permit or water right such as the collection and use of rainwater.

- A water permit or water right typically defines which water (groundwater, surface water) can be diverted, where (point of abstraction), and for which purpose (irrigation, water supply). A permit or right specifies certain conditions under which water use is permitted. A typical condition is that the permit or right is limited, in that it does not permit the use of water that infringes on similar rights of other users. Another condition frequently specified is that the water should be used beneficially and not be wasted, and that return flows should adhere to certain standards.
- The law often stipulates the hierarchy of different types of water use; distinguishing between, for instance, primary use, environmental use, industrial use, agricultural use, water for hydropower etc. In most countries water use for primary purposes has priority over any other type of water use. Some countries also specify a hierarchy of the remaining uses, whereby the most important economic use in that country normally receives a high priority. In other countries all uses of water other than for primary (and sometimes environmental) purposes have equal standing. In times of water shortage the amount of water allocated to all non-primary uses will be decreased proportionally, so that all these users share the shortage equally.
- The law may provide more detailed stipulations with a direct bearing on the allocation of water. The law may stipulate, for instance, that the allocation of water should be equitable. In some countries, in contrast, the law directs that junior allocation rights may not affect senior rights.
- In most cases, however, the legal framework does not provide a detailed "recipe" of how the water should be allocated. The water manager will therefore have to interpret the more general principles as laid down in the law, and translate these into ***operational rules*** for day-today allocation decisions. In many countries the water manager may not even do this without consulting all relevant stakeholders.

Water rights are often granted for a limited period of time, but some may be granted in perpetuity. Countries have developed their own specific water rights systems to solve the issues of planning, developing, allocating, distributing and protecting their water resources. As shown in Table 4, various systems of water rights can be grouped into three basic doctrines: riparian rights, prior (appropriative) rights and public allocation.

**Table 4: The basic systems of water rights**

| **Water rights system** | **Description** |
|---|---|
| Riparian rights | Links ownership or reasonable use of water to ownership of the adjacent or overlying lands, and are derived from Common Law as developed in England. Therefore, these principles are mainly found in countries that were under the influence of the British Empire. |
| Prior | Are based on an appropriation doctrine, under which a water right is |

| | |
|---|---|
| (Appropriative) rights | acquired by actual use over time. The system is developed in the western part of the USA, a typical (semi-) arid 'frontier zone'. |
| Public allocation | Involves administrated distribution of water, and seems to occur mainly in so called 'civil law' countries, that derive their legal systems from the Napoleonic Code, such as France, Italy, Spain, Portugal, The Netherlands and their former spheres of influence. |

**Source: Savenije and Van der Zaag(2000)**

The common law riparian rights system treats water as common property, and was developed in humid regions where water is abundant and water allocation did not cause major problems for individual water users. The riparian rights system has evolved into two basic doctrines: *reasonable use* and *correlative rights*. The *reasonable use doctrine* means that a riparian landowner can divert and use any quantity of water for use on riparian lands, as long as these diversions and uses do not interfere with reasonable use of other riparian landowners. The *correlative rights doctrine* requires that riparian landowners must share the total flow of water in a stream, and may withdraw only their "share" of water for reasonable use. For example, the proportion of use allocated to each riparian is based on the amount of waterfront property owned along a stream and creates equal rights for riparians.

The prior (appropriative) rights regime treats water as private property. Water is appropriated according to "first in time, first in right". In cases of water scarcity, there is no sharing of the shortage in water. Junior users are allocated water after senior users have been satisfied.

The public allocation regime treats water as a public property, and the state is the owner of waters. In this system, water rights are administratively allocated to users through water permits from governments. As the water demands increase and begin to compete for available water supplies during times of water scarcity, the need for active public management of water has been recognized. The introduction of water management through a regulatory permit system is increasingly common among states. This modified system is named as "regulated riparianism" and the rights are called "regulated riparian rights". The regulated riparianism treats water as a public property, and hence is a kind of public allocation water rights regime.

**The box below shows the acquisition of water rights as stated in the Ghana legislation.**

The property in and control of all water resources is vested in the President on behalf of and in trust for the people of Ghana.

- No person shall :

(a) Divert, dam, store, abstract or use water resources; or

(b) Construct or maintain any works for the use of water resources except in accordance with the provisions of water resources Act.

- A person who has lawful access to water resources may abstract and use such water for domestic purposes.
- Any person may apply to the Water Resources Commission in writing for the grant of water right
- The Commission shall on receipt of an application make such investigations as it considers necessary including consultations with the inhabitants of the area of the water resources concerned.
- The Commission shall publish in the Gazette notice of an application and the area in respect of which the application is made.
- A person who claims that his interest will be affected by the grant of water right may notify
- the Commission within three months of the notice in the Gazette of his objection to the grant of the water right an shall specify the grounds of the objection.
- The Commission shall consider the objections made in respect of it and shall after consultation with such persons and authorities as it may consider necessary, determine whether the water right shall be granted.
- Where the Commission is satisfied that the water right shall be granted, it shall so grant the right.
- The Commission may grant water right subject to such conditions as shall be specified in the document for the grant.
- A grant of water right shall be subject to ratification by Parliament.
- Parliament may be resolution supported by the votes of not less than two-thirds of all the
- members of Parliament,
- No water right granted under this Act shall be transferred without the written approval of the Commission.
- Where the grant of any water right is to a statutory corporation or any other public body whose use of the water right ensures to the benefit of the public, the provisions of the Lands Act shall apply for the creation of any right of way or other similar right for the purpose of enabling the works related to the water rights to be implemented.
- Where water right has been granted and the Commission is of the opinion that the water
- resource in any area is insufficient or is likely to become insufficient or is likely to become insufficient as a result of the grant it may by notice in writing to the holder of the water right in that area, suspend or vary any right to abstract or use the water resource in that area, for such period as the Commission considers necessary.
- Where a notice has been issued under subsection (1) the water right shall cease for the period of the suspension or shall be exercisable only as so varied.
- Commission is satisfied that water resources are required for a public it may by notice in writing addressed to the holder of a water right, terminate or limit that right on the grounds that the water is required for public purpose and the right shall cease or shall be exercisable only as so limited.
- The holder of a water right shall be entitled to receive such compensation as may be reasonable in the circumstances in respect of the loss resulting from the termination or limitation of the right he holds and in the absence of the agreement the court shall determine the amount of such compensation.
- If the holder fails or neglects to remedy the default within the period specified the Commission may terminate the water right and inform the holder accordingly in writing.

## 2.6 Principles of transboundary water allocation

For international river basins between countries, there is not always a formal inter-country water rights system but international water agreements defining ownership of the water resources. To mitigate problems of water allocation, the international legal community has established generalized, global legal and economic principles for inter-country river basins, as listed in Table 5. Of the four principles, absolute sovereignty and absolute riverine integrity are the extreme doctrines; limited territorial sovereignty is more moderate; and allocating water based on its economic value is a more recent addition to water conflict resolution. While water markets have received considerable attention and have been applied in a number of intrastate settings, water markets are not yet being developed and adopted at an international scale due to concerns over equity issues of water rights.

**Table 5: Generalized principles of transboundary water allocation**

| Principles | Description |
|---|---|
| Absolute sovereignty | Based on hydrography and implies unilateral control over waters within a nation's territory. It is often the initial claim by upstream riparians during treaty negotiations. |
| Absolute riverine integrity | Suggests that every riparian has a right to the waters that flow through its territory. It emphasizes the importance of historical usage, or chronology. This doctrine is often the initial bargaining position for downstream riparians. |
| Limited territorial sovereignty | Reflects the right to reasonable and equitable use of international waters while inflicting no significant harm on any other riparians. |
| Economic Criteria | Under this principle, the market is used to allocate water among competing users in an economically efficient manner. |

**Source: Wang (2005).**

***Water allocation in international river basins***

Principles underpinning the sharing of transboundary waters evolved quite separately from national water allocation systems. With the 1966 "Helsinki rules on the uses of the waters of international rivers" the International Law Association in 1966 codified the principle that "Each basin state is entitled, within its territory, to a reasonable and equitable share in the beneficial uses of the waters of an international drainage basin." This is based on equity. There was insufficient support within the United Nations to adopt the Helsinki Rules as UN law. This was because many countries with well-developed water systems wanted their current water uses explicitly defended. To counter-balance the equity principle, the obligation not to cause significant harm was formulated, this includes harm to human health or safety, to the use of the waters for beneficial purposes, or to the living organisms of the watercourse systems (Article 7 of the UN Watercourses Convention).

The question is frequently asked: which has legal priority, the right to equitable and reasonable use or the obligation not to cause significant harm? Those riparian states with a stake in the status quo tend to stress the importance of the latter principle (which appears to recognise established uses however inequitable these may be), while those riparians who lagged behind in water development tend to use the former principle to claim waters already used by 'more developed' riparians. The differential application of both principles should, however, be considered a false dilemma. Both principles apply concurrently and represent, as it were, two sides of the same coin. They convey the basic tenet that riparians have rights and duties in the uses of water resources, in line with the second principle of the Rio Declaration: Both principles imply that also downstream countries would need to seek a declaration of no-objection from upstream riparian countries when planning large-scale water development projects. In this context the current World Bank policy which that only require upstream countries to seek a declaration of no-objection from downstream riparians is inadequate. Some authors have argued that the **principle of equity is key to water allocation**, which was also the premise of the 1966 Helsinki Rules. The principle of reasonable and equitable use (Article 5 of the UNWC Convention), however, is defined in general terms. To establish what is an 'equitable share', the UN Convention directs riparian countries to consider a wide variety of aspects (UNWC, 1997) as follows**:**

1. In the application of convention, watercourse states concerned shall, when the need arises, enter into consultations in a spirit of cooperation.
2. Utilization of an international watercourse in an equitable and reasonable manner within the meaning of article 5 requires taking into account all relevant factors and circumstances, including:

- Geographic, hydrographic, hydrological, climatic, ecological and other factors of a natural character;
- The social and economic needs of the watercourse States concerned;
- The population dependent on the watercourse in each watercourse State;
- The effects of the use or uses of the watercourses in one watercourse State on other watercourse States;
- Existing and potential uses of the watercourse;
- Conservation, protection, development and economy of use of the water resources of the watercourse and the costs of measures taken to that effect;
- The availability of alternatives, of comparable value, to a particular planned or existing use.

3. The weight to be given to each factor is to be determined by its importance in comparison with that of other relevant factors. In determining what is a reasonable

and equitable use, all relevant factors are to be considered together and a conclusion reached on the basis of the whole.

Van der Zaag et al. (2002) attempt to define measurable criteria on the basis of which water resources can be allocated to the riparian countries in an equitable manner. Such measurable criteria may facilitate negotiations between riparian countries that are in conflict over the issue. A key parameter for establishing an equitable share is the number of people living in the various parts of the basin.

## 2.7 Priority of water allocation between sectors

Do higher value uses of water need to have priority over lower value uses? Some types of water use add more value to water than others, with a shift towards the higher value use is often promoted (Savenije and Van der Zaag, 2010). High value uses (such as urban water use) often have the potential to mobilise sufficient financial resources to secure a reliable supply. Higher value uses often require higher levels of reliability, meaning larger dams, and hence much larger investments, compared with lower value uses (e.g. irrigation). Often, the higher value uses are able to mobilise even these higher investment requirements. In extreme cases of drought, transfers between sectors will have to be against fair compensation.

The value attained in urban sectors is typically an order of magnitude higher than in agriculture. If water is currently used in the agricultural sector, the opportunity cost, i.e. the value of the best alternative use, may be 10 times higher. Whereas the opportunity cost of water for domestic water use may be highest, the moment water availability is higher than demand, the opportunity cost of the water will fall to the next best type of use due to the availability of water. The proper opportunity cost for irrigation water may therefore be only half, or less, than the best alternative use. We should realise that water for irrigation requires a lower level of assurance of supply than, for instance, water for urban and industrial use.

What is needed is a legal and institutional context that allows *temporary* transfers of water between agriculture and urban areas in extremely dry years. A simple legal provision would suffice, through which irrigators would be forced to surrender stored water for the benefit of urban centres against fair compensation of (all) benefits forgone. In those heavily committed catchment areas where *permanent transfers* of water out of the agricultural sector are required, normally voluntarily negotiated solutions can be agreed, provided the laws allow this to happen.

## 2.8 Water allocation mechanisms

The intra-country water rights systems or generalized principles of transboundary water allocation in inter-country basins provide the basis for various institutional mechanisms for water resources allocation. Dinar *et al.* (1997) discuss the concepts, advantages, and disadvantages of four basic water allocation mechanisms.

The water allocation mechanisms are:

- Public (Administrative) Water Allocation
- User-Based Allocation
- Marginal cost pricing allocation
- Water Markets allocation

In practice, most countries have combinations of these water allocation mechanisms.

*Administrative allocation mechanism* is broadly employed in most of the countries where the governments allocate and distribute water permits as water use rights to different uses. The allocation rules of administrative allocation mechanism can be based on historical facts (such as *prior rights*), on equitable shares in available water volumes (such as *regulated riparian rights*), on individual requirements, or even based on political pressure. The disadvantage is that an administrative allocation mechanism often leads to inefficient use of water and failure to create incentives for water users to conserve water, improve water use efficiency and allow tradable water transfer to achieve best benefits in a whole river basin. In practice, administrative allocation mechanisms typically consist of various inefficient water pricing schemes. Flat rates or fixed charges are common, simple to manage and easy to be understood by users.

*User-based allocation mechanism* is employed in community wells, farmer-managed irrigation systems, and systems managed by water and sanitation associations. "User-based allocation requires collective action institutions with authority to make decisions on water rights" (Dinar *et al*., 1997). A major advantage of user-based allocation is the potential flexibility to adapt water delivery patterns to meet local needs. However, the effect depends on the content of local norms and the strength of local institutions.

*Marginal cost pricing* (*MCP*) *mechanism* sets a price for water to equal the marginal cost of supplying the last unit of that water. The advantage of MCP is that it is theoretically efficient. "Not only are the marginal costs and benefits equal, but also at the efficient price the difference between the total value of water supplied and the total cost is at a maximum" (Dinar *et al.,* 1997). One of the principal limitations of MCP is it is difficult to collect sufficient information to correctly estimate and subsequently monitor benefits and costs (Saunders *et al.,* 1977). MCP also can be unfair. If water prices increase to a sufficient level, low income groups may be negatively affected. Given the above disadvantages and difficulties in implementation, there are few good examples of MCP applications to water allocation in reality.

*Water market mechanisms* allocate water by means of tradable water–use rights and promotes efficient water uses through allowing users to sell and buy freely their water rights. It requires intervention of government to create necessary conditions before markets become operational, including (a) defining the original allocation of water rights, (b) creating the institutional and legal frameworks for trade, and (c) investing in basic necessary infrastructure to allow water transfers. Water markets mechanism is a relatively new concept in many countries, but water markets do exist in Australia. Water markets have attractive potential benefits such as distributing secure water rights to users, providing incentives to efficiently use water and gaining additional income through the sale of saved water. However, there are some challenges in the design of a well-functioning water market. The difficulties include: measuring water, well defined water rights taking into account the variable flows and hydrological constraints, sale-for-cash by poor farmers.

## 2.9 Integrated water allocation planning and modeling

The integrated water resources management is a multiple dimension process centred on the need for water, the policy to meet the needs and the management to implement the policy, which requires integration of various components including physical, biological, chemical, ecological, environmental, health, social, and economic.

***Water allocation plans*** may be made at three levels from national to local: At the level of water rights, operational level and local level. At the *level of water rights*, a water allocation plan deals with the interacting obligations of water users and the regulatory authorities. It may indicate the cumulative rights that are intended to be issued, and it may include the criteria for management at other levels. At the *operational level*, a water allocation plan is concerned with shorter-term, usually annual, management of reservoir storage, river flows, and diversions. At the *local level*, the water distribution rules and priorities are set out (UNESCAP, 2000).

At the operational level, a general comprehensive water allocation procedure is proposed in Figure 4. This procedure starts with setting objectives under certain regulations and institutions governing water rights policy and water allocation mechanisms. Then physical and social investigations, together with hydrological modelling, water quality modelling, economic analysis, and social analysis should be carried out to have a comprehensive water resources assessment. The water resources assessment phase generates the possible options for water allocation. Then a water allocation plan can be obtained by evaluating the possible options utilizing certain criteria considering the factors of water availability, need, cost and benefit. After a plan is made, and its proposals are agreed upon by the representatives of water users and others, it needs to be implemented. To evaluate the performance of the plan, monitoring and reporting are required. Each feedback in this process can provide more highlights in the next iteration. The water allocation plan made at the operational level determines the water flow or volumes for distribution at the local level.

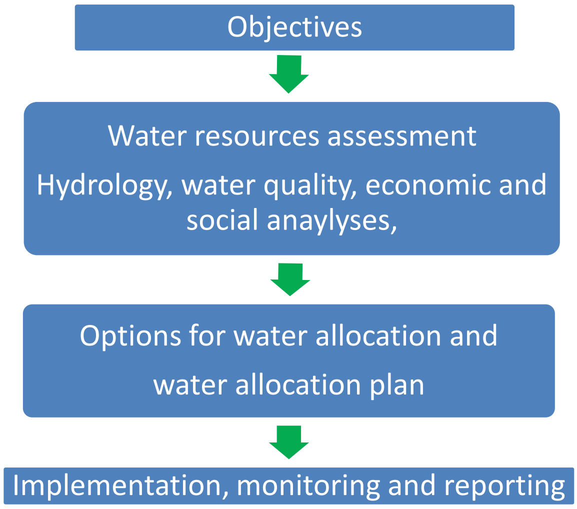
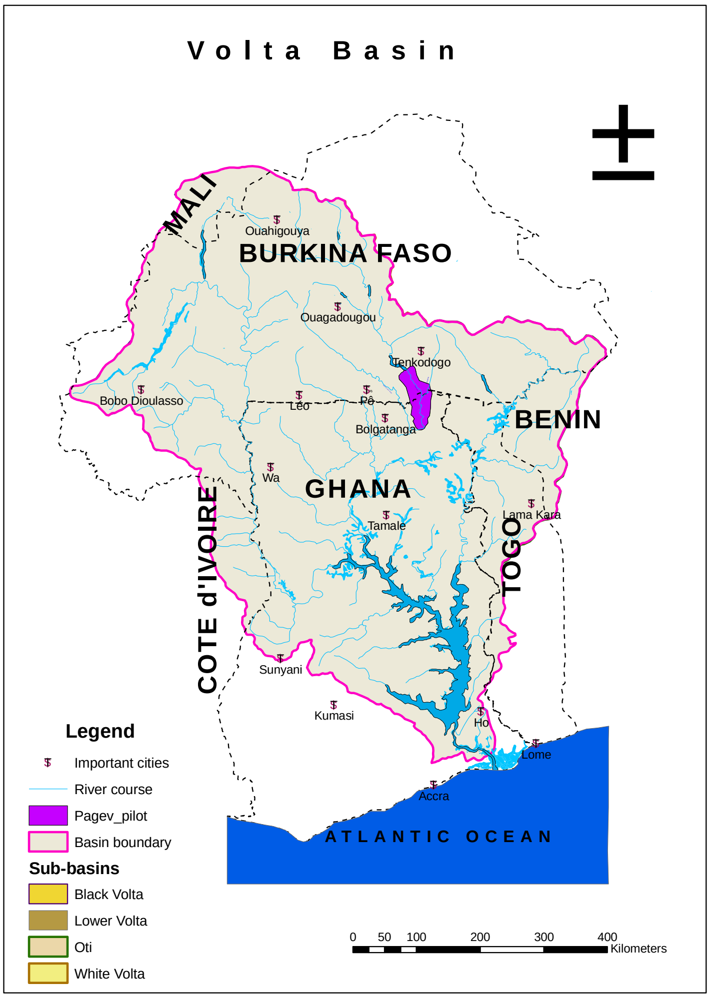



**Figure 4: water allocation planning at the operational level**

## 2.10 Case study: water allocation in Volta river basin shared by six riparian countries

The Volta Basin is a transboundary river system and connects people with diverse cultures and backgrounds. It is a home to nearly 20 million people who depend directly or indirectly on the resources of the river. It is therefore an important asset for the development of these riparian countries namely Benin, Burkina Faso, Cote d'Ivoire, Ghana, Mali and Togo.




The basin is a complex ecosystem which faces development challenges, including environmental degradation, water scarcity and inadequate mechanisms for managing water resources. These challenges called for a basin-wide response that led to the establishment of the Volta Basin Authority (VBA) in 2006 as a formal institution to promote consultations among member countries towards shared management of its basin resources.

In 2006, a water audit was conducted that focused on Burkina Faso and Ghana under the IUCN implemented Project for Improving Water Governance in the Volta River Basin (PAGEV). With the VBA in place, the International Union for Conservation of Nature (IUCN-PACO) collaborated with the former to undertake a water audit, thus updating the information on Ghana and Burkina Faso and gathered information on water resources in the other four riparian countries.

### Model building using WEAP

The essence of the project was to make available information on the available water resources and use from a basin-wide scale and to create awareness of trends in order to inform decision making towards structured management.

The Water Evaluation and Planning System (WEAP) is a decision support tool that was developed by the Stockholm Environment Institute (SEI-US). It is pretty a simple tool to use in assessing availability of water resources in a catchment. This tool has been applied to the

Volta towards building an information base to catalyse shared vision for sustainable management of the basin by riparian states.

***Data requirements***

Data is collected from the national institutions mandated to gather the data. Secondary sources are also explored to augment information and data from national institutions. The data needed to construct the model are as follows:

*a) Land use/cover*

Land use/cover data on the Volta Basin was accessed from the European Space Agency programme on Remote Sensing and its application.

*b) Supply end (resource)*

1) Collect relevant rainfall and evaporation data (fill data gaps in runoffs and to estimate losses from reservoirs).
2) Select relevant gauging stations as key river flow stations for the catchment(s) analysis. Data quality checks are necessary to inspect to ascertain the gaps, or otherwise. Fill the data gaps in the river flow data.
3) Collect relevant information on groundwater resources including water level data from the groundwater monitoring network.
4) Determine the future water availability for all the water audit sections for at least three different climate change scenarios.

*c) Demand end*

5) Collect and compile data on present and future water demands and abstraction from all identified sources:
   - Household / Domestic
   - Livestock
   - Irrigation
   - Industrial
   - Hydropower (existing and planned dams)
   - Environmental flow requirements

In the allocation, these demands must be prioritized based on the countries perspectives and incorporated in the model as such.

6) Build a Decision Support System (DSS) that assesses the water availability and allocation on a daily, monthly or annual basis for all the water audit sections/ catchments in the basin for present and future water uses. The model, depending on the degree of precision and the data available could be built using a daily, weekly, monthly or annual time step. In the case of the Volta a monthly time step model was developed.

**Toward Solutions - Improving land use/cover and water governance**

- Landuse/cover was assessed and analysed for the sub-catchments of the basin. Arable land areas decreased in certain portions over the simulation period. This signal points to loss of fertile lands in the coming years. Forests, on the other hand, have been degraded increasing grassland cover and enhancing loss in soil fertility. The exposure of the top soil has contributed to the accelerated runoffs and erosion, and consequent siltation of the Volta Rivers.
- Land reclamation will be necessary as important step to regain soil fertility.
- Knowledge of the system of data collection and gaps filling in the countries is ascertained and crucial for the basin-wide management. The use of multiple regression analysis and SMAP/HYDROLAB models are being considered by VBA following testing and the convergence of the approaches for specific gauges including Pwalugu station on the Ghana side of the White Volta. Harmonising these perspectives is necessary to provide common datasets and to facilitate common understanding of riparian countries.
- A DSS for water availability and allocation for the Volta Basin was developed that takes into account drier and wetter conditions of climate change while assessing the capacity of existing infrastructure and options for investments to secure water to manage demands.
- Population growth and expansion of key cities in the Volta basin are likely to face water shortages when consecutive rainfalls show downward trends. Alternative sources including groundwater resources in order to store. Building wastewater treatment plants to treat sewage must be reconciled with the water required to treat the waste. An investment appraisal is required to justify this course of action given the rainfall pattern of countries like Mali and Burkina Faso.
- Irrigation agriculture is critical in certain economies including Burkina Faso and Mali where the populations depend on for their livelihoods. The Bagre irrigation fields in Burkina Faso is likely to experience low cropping patters owing to the lack of water and therefore inhibit expansion from the present use of 35% of its potential irrigable area of 30,000 ha. Samendeni irrigation is another area that is likely to face challenges when operations of the dam commences. Bui irrigation however, will have its water requirements fully satisfied.
- Hydropower production especially in Burkina Faso appears not to be attractive due to inadequate water to be harvested. Thus an energy mix such as solar energy may be required to support domestic, tourism and services industry. However, this would require investments.
- From the WEAP Model reviewed and updated, the annual total volume entering the Volta lake to feed the Akosombo dam at the outlets of the three main rivers under the three scenarios are in the range of values as follows:

**Shared Responsibility for Water Resources Management**

The key basis for carrying out this study under the PAGEV project is three pronged: Knowledge, capacity building and good governance. At the national level, stakeholders including the Water Resources Commission of Ghana and its counterpart directorates in the other riparian countries were engaged to move discussions towards consensus building to guarantee sustainable management of water resources. This is leading to the development of a Water Charter for the Volta Basin. The second aspect involved the engagement of technical experts in modeling in the six riparian countries to build capacity in the use of the model in order to build trust for cooperation and to institute mechanisms for data and information sharing across borders.

At the regional and district/municipal assembly levels, the outputs from the model and processed satellite images to develop awareness creation materials for sensitization of communities on the water availability and use to improve water governance.

The decision-support information base therefore, was created to inform constructive dialogues and collaboration on water management between riparian countries while integrating catchment protection in water resources management for poverty alleviation through riverbank restoration and pilot projects aimed to improve livelihoods.

Clearly, the emerging issues on water resources of the Volta basin evolve around development. The Basin Organization should position itself to lead in engaging the riparian states in setting the agenda for basin-wide management of water resources for sustainable development

# 3.0 WATER DEMAND MANAGEMENT

This section presents the principles and practice of water demand management. At the end of the session participants will be able to:

- Balance Water demand and supply
- Define Water Demand Management (WDM)
- Categorise Water demand management measures
- Determine Water use efficiency,
- Understand public education, awareness and behavioural change
- Understand the Legal, Economic, Legal And Institutional Measures for WDM
- Understand Water losses management
- Learn Water demand management practices,
- Understand WDM strategies and their implementing plans

Participants will also benefit from hands-on training on water demand management options modelling.

## 3.1 Balancing water demand and supply

There is a hierarchy of different types of water use depending on their purpose. These are primary use (drinking water supply) and other secondary uses such as environmental, industrial, agricultural, and hydropower. In most countries water use for the primary purpose has priority over other types of water use. The most important economic use in a given country normally receives a high priority. Sometimes uses of water other than for primary (and sometimes environmental) purposes may have equal priority. In the latter case, in periods of water shortage, the amount of water allocated to non-primary uses will be decreased proportionally, so that all these users share the shortage equally.

The domestic water demand includes water supplied to houses or private buildings for the purposes of drinking, washing, bathing and cooking. Industrial and commercial **use** includes water supplied to infrastructure such as offices, stores, hotels, or factories. Water for public use includes water supplied for gardens and fountains, or fire security. Water demand varies depending upon the season, month, day and hour. Seasonal or monthly variation is prominent in Sub-Sahara Africa.

Many water uses are at least partially consumptive, meaning that the water abstracted will not return to the local water system or cycle. Water uses that are non-consumptive allow other consumers to use the same water afterwards. An example is the water used to generate hydropower being released from dams for downstream or environmental purposes. Water which generates return flows in principle are available for other uses. However, return flows may have a lower quality than the water originally abstracted, which can limit its re-use.

One aspect of integrated water resources planning and management is the need for water allocation by balancing the supply and the demand-sides of water resources. Traditionally, supply driven water management focused on water resources available without managing the demand-side.

- Traditional approach has led to over-use of the resources, over-capitalization or pollution.
- Historically, more finance has been spent on supply and not enough on efficiency. There is an economic benefit to be gained by investing in water efficiency.

## 3.2 Definition of WDM

In most of the literature the definition of Water Demand Management (WDM) and water conservation are similar. Water Demand Management is a management approach involving selective conservation measures and economic incentives to promote efficient and equitable use of water and which decreases the demand for water (White, 1999). WDM can be defined as a strategy to improve efficiency and sustainable use of water resources, taking into account economic, social and environmental considerations. WDM also refers to any socially beneficial action that reduces or modifies average or peak water withdrawals or consumption consistent with protection or enhancement of water quality. WDM corresponds to the use of pricing, quantitative restrictions and other devices to limit the demand of water. There is increasing demand for water and competition for limited water resources among different users due to urbanization and rapid population growth.

There is a growing study results on water conservation that show it is cheaper, faster and better to increase efficiency of water use than to continue solely relying on new supplies to meet the demands of a growing population. For almost all ranges of water needs, it is possible to increase the efficiency of water use without reducing the service level.

***Categorizing Water Demand Management Measures***

There are many different WDM measures. The range of WDM measures (tools and techniques) are categorized as follows:

- By type of tools used (i) structural and operational measures – use of devices, retrofitting, leakage control (ii) non-structural –water pricing, education, legal, socio-political
- By types of incentive: (i) legal obligations (ii) economic incentives (ii) motivation through public education
- By time horizon (i) emergency measures (ii) medium term measures (iii) long term measures
- By sector where the measure is applied (i) urban, (ii) industrial (iii) agricultural (other)

- By location of the water supply system (i) water treatment (ii) distribution network (iii) delivery and consumption point
- By the entities bound to carry out the measures (i) local authority (ii) service provider (iii) end–users

WDM strategies can be grouped as shown in Figure 5, based on the kind of tools and the entities selected to carry out the measures.

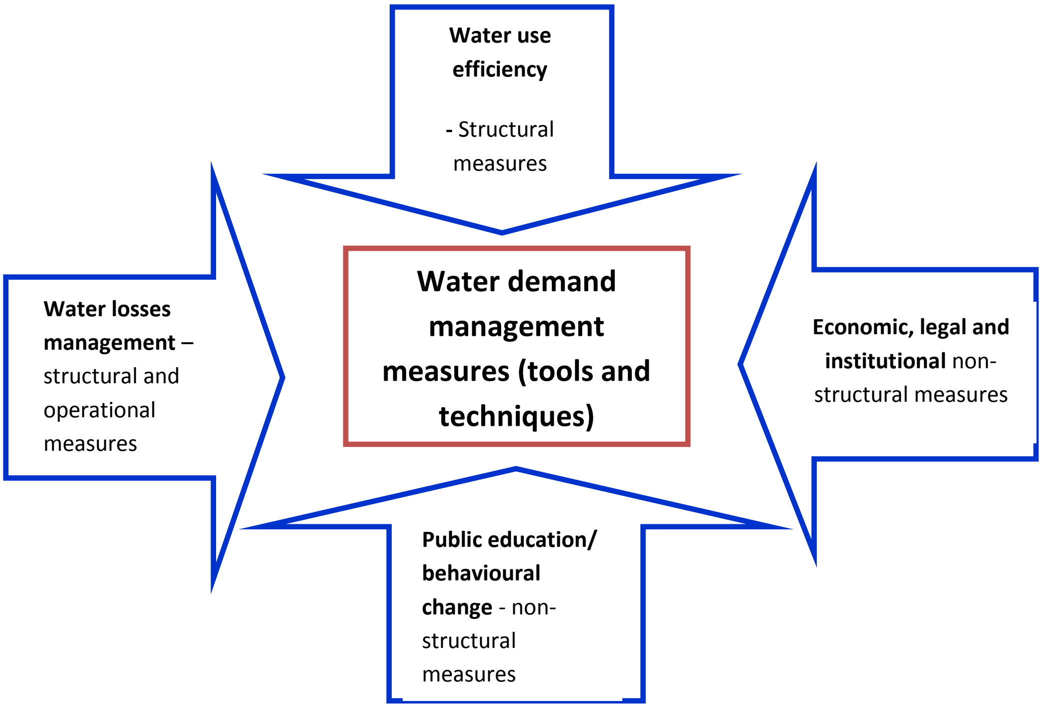



**Figure 5: WDM measures (tools and techniques)**

## 3.3 Water use efficiency

There are structural and operational measures for increasing water use efficiency to achieve better control over water demand. These measures include use of water efficient devices and retrofitting, and water use restrictions during periods of water shortages. The measures that are often carried out in-house to conserve water are categorized as follows:

- ***Water efficient Toilets:*** water saving Low flush and double flush toilets, WC Cistern dams to reduces amount of water required to fill a cistern after each flush,
- ***Water efficient Taps***: water saving taps and shower heads, spray taps, sensor taps, supply restrictor valves,
- ***Water efficient appliances***: water efficient washing machines and dishwashers, water efficient heating and cooling systems; efficient water use in gardening, urinal controls, and waterless toilets and urinals (dry sanitation)

### 3.3.1 Water Saving in Toilet Cisterns

The estimated water use frequency by people for by high-volume, low-volume and dual flush toilets is 5 flushes per person per day. The actual saving for a household will depend on the number of people in the household and the number of people home during the day. McKenzie et al. (2008) provides water efficient techniques for WDM:

***a) Low-volume toilet cisterns.*** Low flow toilets, typically use 6 litres of water and are available in the same operating designs as high volume (10 to 13 litres) toilets. There are three types of low flow toilets: gravity tank toilets, flushometer-tank toilets and flushometer-valve toilets.

***b) Dual flush toilet cisterns.*** The dual flush toilet operates in the same manner as the normal gravity toilet but also allows the user to select either a full flush (±6 or 9 litres) for solids or a half flush (±3 or 4.5 litres) for liquids. Some designs operate with two handles (levers) and others with one handle that can be turned or depressed in two directions for the full of low flush respectively.

***Benefits of low volume and dual flush toilets*** - low volume toilet cisterns can save thousands of litres of water per year. In addition, dual flush toilets can save even more water by allowing a minimal flush for liquids. The savings often provide payback on the installation costs within a matter of months. Low volume toilets and especially dual flush toilets can save significant amounts of water if correctly installed by plumbers, based on applicable rules and practices.

***Toilet retrofit devices.*** Toilet retrofit devices are used in residential and non-residential water conservation programmes to reduce the amount of water needed to flush high volume toilets that use 10 to 13 litre cisterns. Low volume cisterns (6 and 9 litres) as a rule cannot accommodate retrofit devices, however, in some instances they can be adjusted with dual flush devices for low volume toilets. The most common devices and adjustments include:

- Displacement devices;
- Early closure devices; and
- Dual flush adaptors.

### 3.3.2 Water Saving in Taps

The basic measures to reduce water use by taps are:

***a) Low volume taps.*** Low volume kitchen and lavatory taps look similar to conventional, high volume fixtures. Reduced flows can be achieved through the use of aeration, flow control, and/or spray devices.

***b) Tap retrofit devices.*** The flow control devices found in low volume taps are also available for most high volume taps. In most cases, retrofitting a high-volume tap is less expensive than replacing the entire unit, often with similar water savings.

***c) Aerators.*** Tap aerators are circular screen disks, usually made of metal that are screwed onto the head of the tap to decrease flows. Aerators reduce flows by mixing air with water, giving the sensation of ample water yet at reduced volumes. An aerator is a simple economical and effective device for reducing water use by taps.

***d) Metered-valve, self-closing, and sensor-activated taps.*** The following explains the working of each of these retrofit devices:

- Metered-valve taps deliver a preset amount of water before shutting off;

- Self-closing (spring loaded) taps feature a spring-loaded knob that automatically shuts off the water when the user releases the knob;

Sensor-activated taps contain light and motion sensing devices that cause water to flow once the sensors detect motion directly in front of them. When the user steps away, the tap turns off. The sensor-activated taps require a power supply to drive the sensors, which may be a limitation in certain situations. The sensor activated taps have the following benefits: (1) They are more water efficient than many other taps because they operate only as long as required; (2) They are hygienic since no contact is made with the tap.

***e) Repair of leaking taps***

Prompt repair of leaks prevent water wastage in premises. Flat rate users may not repair leaks in the shortest possible time. Leaking taps are one of the most common sources of water wastage in many households. Taps should be checked regularly for leaks at the tap head and for seepage at the base and on connections. Tap repairs normally include the following measures:

- Replacement of worn washers. Dripping taps or those losing a steady stream of water are most often caused by a worn washer, which is quick and inexpensive to replace.
- Tightening or repacking tap. Leaks at the tap stem (just below the handle) or base usually indicate that the fixture needs to be tightened or that new packing needs to be placed in the packing nut. **3.3.3 Water Saving in Showerheads**

Considerable savings can be made using a quality "low-flow" showerhead in both domestic and commercial installations. Care must be taken to ensure that the low flow showerheads are of a high quality, or the individual using the shower will not be satisfied and may change back to the original showerhead. Considerable research has been carried out on the issue of low flow showerheads and it is conclusive that the use of such devices will save significant quantities of water without reducing the quality of service to the user.

The three basic measures to reduce water use by showerheads are:

***a) Low-volume showerheads.*** Low volume showerheads improve water use efficiency compared with high volume showerheads through such features as improved spray patterns, better mixing of air with water, and narrower spray areas to give the user the "feel" of water without high-volume flows. A variety of spray and other designs options are available for low-volume showerheads. A typical flow rate pressure relationship is shown in Showerheads using a flow restrictor often cost less than fixtures that have a flow control device. A showerhead flow-control device is a disk containing an elastic O-ring that is controlled by pressure. Under high pressure, the O-ring flattens and reduces water flow, under low pressure the O-ring relaxes and allows a higher flow, providing smoother changes in spray pattern compared with flow restrictors.

***b) Shower adjustments.*** In addition to replacing inefficient showerheads, two adjustments can be made to reduce their water use:

- Reducing the water pressure will reduce water used in the shower, unless the consumer increases the length of time taken to shower. In general, reducing water pressure will result in water savings. Pressure reducers can be installed to reduce pressures in a building either at the supply point into the building or at certain points inside the building in the case of larger premises. By reducing the water pressure (within flow requirements for each floor and water supply connection) the flow to taps and other fixtures can be reduced.

***c) Showerhead retrofit devices.*** Two devices are commonly used to restrict flows on high volume showerheads: temporary cut-off valves and flow restrictors.

- *Cut-off valves.* Cut-off valves can be attached to existing showerheads to reduce water use, but should be used only if they are designed and installed properly because they can cause scalding.
- *Showerhead Flow Restrictors (Disk Inserts).* Showerhead flow restrictors (disk inserts) are typically inexpensive plastic or metal disks with a small hole in the centre. It reduces the flow of water and can be fitted into the coupling of some older, high volume showerheads. This will be where the shower arm is connected. Due to the relatively crude design, many disk inserts are not compatible with the varied flow and spray characteristics of existing showerheads. Disk inserts are generally no longer considered an acceptable water conservation measure.

#### 3.3.4 Water Saving Urinals

The basic measures to reduce water use by urinals:

***a) Low-volume urinals.*** Low volume urinals typically use 3 litres per flush as opposed to 8 to 12 litres used by high volume urinals. High volume flushometer-valve urinals can be replaced with these low flow units, often with no modifications to the bowl or to wall floor connections.

***b) Urinal retrofit devices.*** The four main types of urinal retrofit devices are as follows:

*Flush-valve replacement and retrofit.* For high volume urinals, the flush valve can be replaced with a 3 litre flush valve, although not all types might be suitable for retrofitting. The installation may require some modifications to the connection and, in some cases, replacement of the urinal bowl.

*Flush-valve efficiency adjustments.* Water use by conventional, high volume flush valves in urinals can sometimes be reduced by turning the adjusting screw under the cap located on the horizontal portion of the valve. This adjustment can save up to 3 litres per flush and should not adversely affect the fixture's flushing performance.

*Timers for siphonic-jet and blowout-valve urinals.* Timers or time clocks can be used to control the frequency of flushing or water flow can be installed on urinals that flush periodically or continuously, such as siphonic jet and blowout-valve urinals. The timer can be set to operate only when a building or facility is in use. Push buttons should always be installed on existing siphonic urinals to flush the urinal only after use.

*Infrared and Ultrasound Sensor Activated Flush Controls.* These are use in public buildings to save water after each use.

***Benefits*****:** The replacement or retrofitting of automatic flushing urinals is often a very effective form of WDM and the payback is generally a matter of several months. All automatic flushing urinals should be identified and replaced as a matter of priority especially in schools and other communal buildings (McKenzie et al., 2008).

## 3.4 Public awareness and education

Public awareness and education are essential components of successful water conservation program. The purpose of effective public and stakeholder education and awareness measures to enhance wise use of water and direct restrictions on use is to increase water use efficiency. School education is also an important means for instilling water conservation awareness in the pupils. Inform the public about the basics of water use efficiency using pamphlet, newsletters, TV/radio-programs, web sites, competition and exhibition/fair on the following:

- How is water delivered?
- What are the costs of water services?
- Why is water conservation important?
- How can the public participate in conservation efforts?

**WDM Education within the Utility Organisation**

Before the consumers can be educated and public awareness raised, it is necessary to ensure that the personnel working for the water supplier are fully aware of the need to manage water demand. This can be done through training sessions to introduce and explain in detail the various concepts of WDM throughout the water supplier’s organisation and the service provision process. Training sessions can be developed at various levels of detail and for different levels of responsibility such as top management; middle management and operational staff.

Studies indicate that it is difficult to present training courses to top management over more than one day due to their time limitations and commitments. For this reason it is necessary to develop an intensive one-day training course that will address all key WDM issuesthat provides the necessary detail.

The training of the middle management and operational staff can be undertaken over a period of days. Middle management personnel are often enthusiastic about WDM and interested in gaining insight on the various aspects of WDM such as internal water audits, water-wise gardens and retrofitting of taps and toilets. One of the key initiatives that all water utilities should undertake is to ensure that their own offices use water efficiently. By implementing various WDM initiatives in-house, the water supplier creates an awareness of water conservation to all employees and visitors to the organisation.

In order to implement such measures, the water utility should develop and implement an action plan, which should include the actions indicated below:

- Carry out a night-flow analysis for consumption and/or leakage for all sources in the building;
- Monitor water meter fluctuations such as sudden and unexplained increases;
- Carry out  water use surveys for their buildings;
- Identify and implement appropriate water saving initiatives such as, low flush toilets, low flow showers, self-closing taps, waterless urinals,;
- Analyse cost of water saving strategies to determine the added value of water saving initiatives;
- Introduce internal policy promoting low consumption devices;
- Promote successes to encourage staff to reduce their water consumptions. Share experiences with other organisations.
- Identify other benefits from managing demand – i.e. reduced energy use, $CO^2$ emissions, deferment of capital expenditure, etc.;

**WDM Education and awareness campaign in Schools**

School education is one of the most important aspects of awareness raising for a WDM strategy. If the children can be convinced of the benefits to the community and specifically the environment, of WDM measures, they will convey the message to their parents. A large amount of material is already available to assist water suppliers in setting up and implementing school education campaigns in WDM. In some countries, the water suppliers and government authorities work together to create an education campaign on WDM that forms part of the education Syllabus.

When considering a school campaign the following elements should be included:

- Set up a site visit to a water treatment works and a sewage treatment works;
- Provide suitable educational material and kits for the classroom, which can include projects such as undertaking water audits in the school, painting competitions, essays on water conservation;
- Schools retrofitting projects where the school ablution facilities are retrofitted with low flow showerheads, dual flush toilets, and low flow taps. Such measures are can be implemented in parallel with a water-auditing project to monitor the savings achieved and to create awareness for water conservation throughout the school.
- Exchange details of other WDM projects where measures were taken to reduce the wastage in schools.

**Education and awareness campaign targeting households**

Education at home can be achieved through a variety of measures and, as was the case with the school education campaigns, considerable material is already available to be used as a starting point for a campaign. The materials required will vary from one area to another and from country to country, depending on the level of service and the availability of the specific media to the consumer. For example in many areas, where consumers do not have access to television, media campaigns must be tailored for the radio or through leaflets and newspaper articles. In other cases, where some of the consumers may be illiterate and other approaches must be developed.

It is necessary to evaluate the consumer base and their needs in order to establish the most appropriate means of spreading the water conservation message after which an appropriate strategy can be developed and implemented.

**Public Awareness Campaigns**

Public awareness campaigns are very important in spreading the message of water efficiency to the consumers. Most water suppliers wishing to promote WDM organise various activities designed to create awareness through:

- **Pamphlets** and/or leaflets on how to save water to be sent to all consumers with their water and electricity bills where appropriate;
- **Stickers** on how to save water, which are displayed in all hotel bathrooms and any public toilets at airports, railway stations, government buildings;
- **Articles and publicity** in newspapers and popular magazines, highlighting aspects of water conservation;
- **National water weeks**, in which government officials and well known celebrities undertake to create awareness of water conservation issues;
- **Events** in which the consumers are encouraged to participate in some activity which highlights the value of water conservation. For example, there may be a competition to develop a new water conservation slogan for the water supplier, or to demonstrate how much water can be saved in a household over a period of several months;
- **Water-wise posters** displayed effective garden watering and irrigation;

These items represent only a few of the many approaches that can be adopted to promote water conservation to the public in general. In most cases, a water supplier will work closely with government departments. WDM interventions should not be done in isolation to other similar initiatives.

## 3.5 Economic, legal and institutional measures

***Water pricing and Economic measures***

Economic techniques depend on

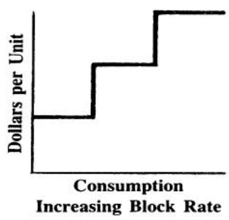
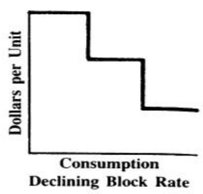
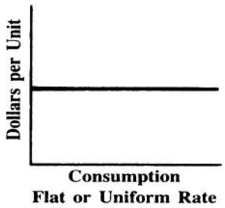
- Water pricing and incentives such as rebates, and tax credits
- Disincentives such as real cost, penalties or fines
- A direct means of controlling water demand and generating revenues to cover costs
- Complementarity to other measures of water demand management

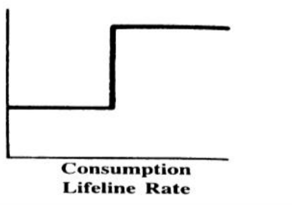
Water rate structure should be such that it:

- generates sufficient revenue to cover costs,
- allocates costs to different types of water uses, and
- Provides incentive for conservation.

If the water price remains low, there is no incentive for the consumers to install water-saving devices or technologies. A pricing solely based on a flat rate regardless of volume used or a system based on property value would not be effective in water conservation. In principle, there are many different rate structures that could generate the same total revenue for a water utility. Water pricing levels should be such that the associated costs are recovered to ensure a sustainable operation and that it guards against water wastage.

**Table 6: Tariff structure**

| | |
|---|---|
| Increasing (progressive) block rate or *Progressive block rates encourage conservation and reduce waste.* A proper well maintained metering system is a pre-requisite condition for that. |  |
| Decreasing block rate |  |
| Fixed monthly charge ($/month), this does not encourage water conservation, |  |

| | |
|---|---|
| Lifeline tariff |  |

**Legal and Institutional Measures**

The economic policies, government regulations and laws, standards on appliance redesign and marketing should promote water efficiency. Policy to promote water saving devices and encouraging water savings in industries should be promulgated and supported with rules and regulation. Rules and regulations that form the basis of WDM policy include:

- Use of specific plumbing fixtures and devices, *Example: Code of practice for water fixtures*
- Subsidies for water saving devices and systems used in treating and reusing waste water
- Regulation for resale of water
- Requirement for rainwater harvesting, Example: Regulations in some cities
- Requirements of water reuse and conservation in industrial complexes.

## 3.6 Water losses management

Substantial savings can be achieved and extension of water supply facilities can be avoided or minimised by reducing water losses or unaccounted-for water (UFW) through leakage detection and control. By reducing UFW, water utility can be in better financial situation and will be stronger position to achieve its financial self-sufficiency and long term sustainability. A low rate of unaccounted-for water is one of the best overall indicators that a water utility is successful. When assessing water losses from a water distribution system it is standard practice to split the losses into two components: Real and Apparent Losses. The total Losses are estimated as the difference in the System Input and the authorised Consumption.

***Real Losses***

Real losses represent the physical water losses (i.e. leakage) from the pressurised system up to the point of measurement of customer use. These real losses represent actual water supplied to the system that is lost into the ground. In many cases, the lost water may return to the natural river system through the storm-water network or through the sewer network. Losses inside the properties, such as a leaking toilet, would not be considered as part of the real losses, since they take place after the property boundary. Such losses are termed internal plumbing losses and are considered part of the metered consumption in cases where household meters are present and un-metered consumption in cases where household meters are not present. The annual volume lost through all types of leaks, bursts and overflows depends on frequencies, flow rates, and average duration of individual leaks.

The **Real Losses** are then calculated directly as the difference between the total losses and the estimated apparent losses.

***Unavoidable Annual Real Losses (UARL).*** An interesting and important concept (Lambert et. al., 1999) concerns the level of leakage in a system that cannot be avoided. No system can ever be completely free from leakage no matter how new or well managed. This concept of Unavoidable Annual Real Losses (UARL) is now one of the most useful and important concepts used in Component Based Leakage Management. Effectively, it is a simple concept based on the fact that no system can be entirely free from leakage and that every system will have some level of leakage which cannot be reduced any further. Even a new reticulation system with no use will have some level of leakage, although it may be relatively small. The minimum level of leakage for a system is the lowest level of leakage that can be achieved for the given system based on the following assumptions:

- The system is in top physical condition and is well-maintained;
- All reported leaks are repaired quickly and effectively;
- Active leakage control is practiced to reduce losses from unreported leaks.

***Burst and Background Estimate (BABE) techniques.*** In leakage management in UK, leaks found in water supply system were split into two categories – those large enough to warrant serious attention with regard to location and repair and those that were too small to warrant such attention. The larger more serious leaks that warrant direct attention are referred to as **bursts** while those that are too small to deserve such attention are referred to as **background leaks**. The threshold between bursts and background leaks is not fixed and can vary from country to country. In the UK, a threshold limit of $0.5 m^3/h$ is used, while in South Africa a lower limit of $0.25\ m^3/h$ is considered more appropriate. In other words:

*Leaks > $0.25\ m^3/h$ = Bursts and*

*Leaks < $0.25\ m^3/h$ = Background Leaks*

***Apparent Losses***

Apparent losses represent the unauthorized consumption (theft or illegal use), plus all technical and administrative inaccuracies associated with customer metering and billing. It should be noted that the Apparent Losses tend to be low (20% or less of the Total Losses) in well-managed systems but can be high (in excess of 50% of the Total Losses) in poorly managed systems. In areas of low payment or where a flat rate is used, the Apparent Losses tend to be relatively high since there is little incentive for consumers to curb their water use and the actual use is often significantly higher than the assumed unit use used to calculate the tariff. The assessment of the Apparent Losses is always a difficult and often subjective exercise. Considerable effort is currently being devoted to the quantification of apparent losses through the International Water Association (IWA), however, the results were not available for inclusion in this report. An estimate should therefore be made from local knowledge of the system and an analysis of technical and administrative aspects of the customer metering system. While in a normal well-managed system, the Apparent Losses normally constitute between 10% and 20% of the total losses. The Apparent Losses are generally considered to be losses associated with:

- Meter error;
- Unauthorized use;
- Administrative error.

Apparent Losses represent the water that escapes the revenue system and any reduction in Apparent Losses will result in a greater income to the water supplier at the effective selling price of the water. In some African situations the Apparent Losses can be very high and can even exceed the physical losses, especially in cases where levels of payment are low and the payment is based on a flat rate rather than measured consumption.

**Leakage management and control**

Total water loss or the Unaccounted-for water (UFW) represents the difference between "net production" (the volume of water delivered into a network) and "consumption" (the volume of water that can be accounted for by legitimate consumption, whether metered or not).

UFW = “net production” – “authorised consumption”

Non-revenue water (NRW) represents the difference between the volume of water delivered into a network and billed authorized consumption.

NRW = “Net production” – “Revenue water” = UFW + water which is accounted for, but no revenue is collected (unbilled authorized consumption).

**Table 7 Drinking Water balance**

<table>
<tr><td rowspan="10">Annual System Input Volume</td><td rowspan="4">Authorised Consump-tion</td><td rowspan="2">Billed Authorised Consumption</td><td>Billed Metered Consumption (including water exported)</td><td rowspan="2">Revenue Water<br>(RW)</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled<br>Authorised Consumption</td><td>Unbilled Metered Consumption (water used at GWCL premises)</td><td rowspan="8">Non-Revenue Water (NRW)</td></tr>
<tr><td>Unbilled Unmetered Consumption (fire fighting, flushing, and GWCL premises)</td></tr>
<tr><td rowspan="6">(UFW)<br>Water Losses</td><td rowspan="3">Apparent<br>Losses</td><td>Unauthorised (illegal) Consumption</td></tr>
<tr><td>Metering error,</td></tr>
<tr><td>Billing inefficiencies, and flat rates</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Reported Bursts and Leaks</td></tr>
<tr><td>Background losses in mains and service lines</td></tr>
<tr><td>Leakage and Overflows at Storage Tanks</td></tr>
<tr><td>**Block 1**</td><td>**Block 2**</td><td>**Block 3**</td><td>**Block 4**</td><td>**Block 5**</td></tr>
</table>

## 3.7 Developing a WDM strategy and implementing plan

Increasing water use efficiency remains the key strategy for water conservation, and it involves either replacing water-use equipment with more efficient types or through finding and repairing leakage points in the water distribution system to conserve water. When water is underpriced it often leads to the abuse and inefficient use of the resource.

A proper WDM strategy will typically involve many different measures, which are selected to suit a particular water supply system. For example, in many towns with very high levels of leakage, the WDM strategy may involve leak detection, pressure management, retrofitting, education/awareness and new household water metering. Each water supply system is unique to some degree and the measures selected for one system will not necessarily be appropriate for another.

In urban water supply, Kanakoudis (2002) explains that conservation of water is achieved by combination of the following:

- Economic measures or economic instruments such as appropriate water price policy and water price increases;
- Structural measure or technical instruments such as retrofitting with water saving devices, leakage detection programme; and
- Promotional instrument, a non-structural measure such as public education

The WDM strategies to make water available to meet demand include:

1) Increase system efficiency by utility managers:
   - No change in usage, but change in system operation
   - Leak detection and repair, pressure reduction
2) Increase end use efficiency among users and utility managers
   - Promote less resource use by consumers by using water advertising, education and use of water efficient devices (low volume flush, shower heads, dish washers, washing machines)
   - Efficient watering of public open spaces
   - Water efficiency in the planning, design and construction of homes and buildings
3) Improve the market on resource usage
   - inform consumers about full cost of resource
   - full cost pricing, universal metering, information on impact of excessive water use
4) Promoting substitute resource use
   - Provide service via local resource not being used
   - encourage rainwater use and grey-water reuse
   - Dry sanitation, plants adapted to local rain fall

Resources available to reduce demands in normal years include long-term water conservation and wastewater recycling.

*Long-Term Conservation*: Water conservation reduces demand for water through improvements in efficiency and diminishing water waste. A carefully planned and implemented long-term water conservation program can reduce water consumption over years. Review of previous conservation efforts, identification of new measures with a screening for feasibility (including water savings estimates and cost-effectiveness), will lead to a list of viable conservation measures. These measures should then be consolidated into three or four programs that can be combined with supply options to meet future demands. Each program could consist of up to ten or fifteen measures. Suggested groupings of measures are listed below:

- Current Codes and Regulations: Ordinarily, these may not be accounted for in the base water demand. These programs can be used to produce what can be called a "net demand" projection. Net demand means base demand minus the effects of implemented conservation programs.
- Minimum Program - contains water conservation measures currently being planned for the next ten years.
- Moderate Program - contains cost-effective water conservation programs that save more water than the minimum program.
- Maximum Program - consists of a very aggressive conservation program that goes beyond the moderate program and is made of measures that save the most water.

These programs will each have a time stream of costs and water savings that can be integrated with various supply options.

*Short-Term Conservation*: During droughts short-term water conservation programs could help balance available water supply and demand.

## 3.8 Benefits and experience of WDM

Water conservation is necessary in countries which are water stressed and experience water scarcity due to prolonged droughts or low and unreliable rainfall. It is also necessary where there is a shortfall in the urban water supply due to limited funds to expand water treatment facilities, as in the case of Ghana. Water conservation and efficient utilisation has the potential to reduce the huge investments required to expand water supply systems to meet the growing demand and will contribute immensely to sustainable development. The conservation of water resources is a key water policy objective which has to be achieved through the promotion of efficient utilisation and conservation of water by operators and consumers.

**Benefits of Implementing WDM**

Substantial economic, social and environmental benefits will be generated by using water more efficiently, by implementing water demand management strategies, and supplementing the supply management options.

*Economic benefits and costs*

- Reduces water demands (30% - 50%) with no deterioration in life style or service level.
- Significantly reduces capital requirements for expansion of water supply and lowers operating costs
- Leads to more financially sustainable water systems

*Social benefits and costs*

Water savings from WDM makes water become available for equitable distribution. Water becomes affordable for users, since water efficiency can be translated into lower tariffs.

**WDM Practices and Experiences**

The implementation of a ten-year water saving programme in the United States from 1985 to 1995 showed that urban water consumption could be reduced at an average rate of 25% through household water saving devices (Kanakoudis, 2002). To date over 2.3 million low-flow toilets have been retrofitted in California State (Dickinson, 2003). The potential water conservation due to showerheads and toilet alone was estimated to be up to 32% in a residential water end-use study in USA (Dickinson and Maddaus, 2003).

Australia has decreased significantly the volume of water used for flushing water closet (WC) from average of 11-13 litres per flush to less than 4 litres per flush, due to the development of the dual flush WCs (White, 1999; Day and White, 2003). In 1989, Australia made it mandatory for all new WCs to be fitted with a 4.5/9.0 litre dual-flush cistern. In 1996 the authorities further tightened standards and reduced the dual-flush to 3.0/6.0 litres (Sharma, 2004). All water closets manufactured in Australia are now 3.0/6.0 litres dual flush (White, 1999; Day and White, 2003). The change in water closet efficiency has reduced the per capita demand by nearly 20 litres per person per day. The residential retrofitting programme in Sydney has resulted in average reduction in water demand of 23±5.5m$^3$/year per participating household at the 95% confidence level (White and Fane, 2002).

## 3.9 Water demand management options modelling

The adoption of WDM option is based on analysis of options. Figure 6 presents the levels of analysis. The WDM option model is used to evaluate the cost of options and the options with least cost (present worth) are selected for implementation.

| ***Option category level*** | ***Option level*** | ***Variable level*** |
|---|---|---|
| *Domestic end use level* | *shower retrofits* | *Cost of option* |

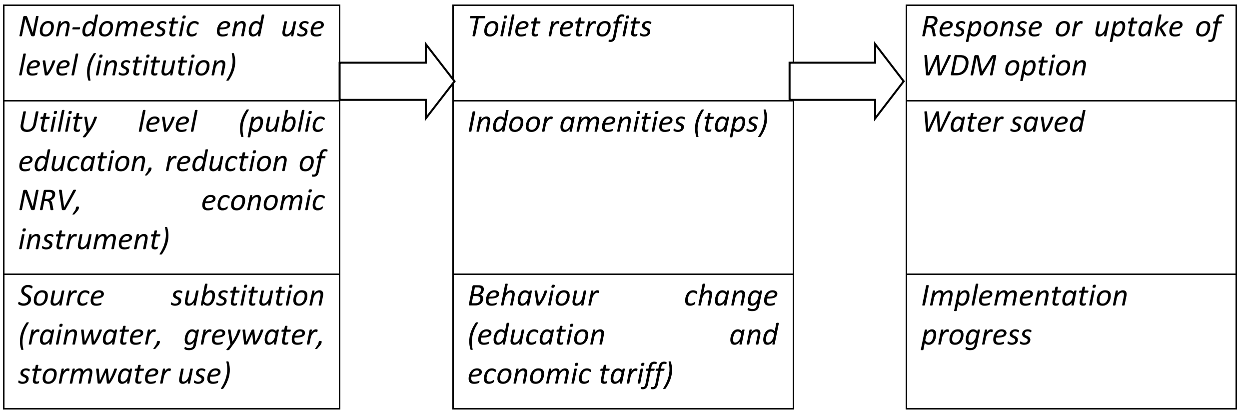



**Figure 6 Levels of WDM options**

**Case study of Cost of retrofitting and cost recovery period**

This case is a study on residential water use and water saving potential in an educational institution in Ghana, and focuses on the following:

- *Water end-*use analysis,
- Water conservation potential using toilet retrofits, shower retrofits and behaviour change towards the use of taps,
- Cost recovery period *for installation of water efficient devices.*

***Water end-use analysis:*** In water end use analysis, the demand for water is considered as a service or 'end-use' of the water such as clothes washing, showering, flushing of toilet etc. Water end-use analysis defines the ways customers use water and it involves customer survey of water-using appliances (WCs, showers, taps) and water-using practices such as frequency of WC flushing, bathing and showering, and clothes washing (White and Fane, 2002). The end-use analysis is used to estimate the amount of water to be conserved and provides a basis for development and evaluation of demand management programme and end-use efficiency. It helps to quantify the reduction in water demand due to residential retrofit programme.

A case study of water end-use in the students' Residence on a University campus was conducted. The average per capita water use for brushing by students was 8.39±0.97 litres per day at tap flow rate of 15.80±1.66 litres per minute at the 95% confidence level. The average time for water flow during brushing of teeth was 27.16±1.58 seconds/brush at the 95% confidence level. The amount of water used for brushing could be reduced if the time allowed for water to run while brushing is reduced or turn the tap/faucet off while brushing. The standard flow rates for lavatory faucet (hand-wash tap) are 9.5litres/min in USA and 6.0-9.0 litres/min in UK (Twort *et al*., 1994; Dickinson *et al*., 2003). These flow rates are lower than the average value (15.80±1.66litres/min) obtained in this survey. Table 8 shows the descriptive statistics of the components of water use. The per capita water use for drinking water, cooking, washing clothes and other water uses were 1.63 ± 0.28, 4.71 ± 0.93, 6.87 ± 0.71 and 1.92 ± 0.58 respectively.

**Table 8: Descriptive statistic of the components of water use in a university (Litres per day)**

| Water End-use | mean and standard error | standard deviation | Range |
|---|---|---|---|
| Bathing | 61.90 ± 4.06 | 24.50 | 30.44–139.14 |
| Flushing of WC | 29.7± 3.11 | 18.79 | 13.65– 87.9 |
| Brushing | 8.39 ± 0.97 | 5.85 | 0.50–36.77 |
| Drinking water | 1.63 ± 0.28 | 1.68 | 0.0–10.0 |
| Cooking | 4.71 ± 0.93 | 5.63 | 0.0–30.0 |
| Washing clothes | 6.87 ± 0.71 | 4.29 | 0.0–24.29 |
| Other water uses | 1.92 ± 0.58 | 3.49 | 0.0– 31.0 |
| Per capita water use | 115.12 ± 5.33 | 32.17 | 50.47–204.28 |

**Source: Oduro-Kwarteng et al. (2009)**

***Water conservation potential.*** Table 9 shows the estimated per capita water use with and without water saving technologies. The average per capita water use obtained from this survey was 115.12±5.33 litres per day at the 95% confidence level. This amount could be reduced to about 80 litres per capita per day through retrofitting with water saving devices and creating awareness on water conservation among students. An amount of 36 litres per capita per day, representing 30.85% could be conserved.

**Table 9: Water end-use with and without conservation in litres per capita per day**

| Water End-Uses | Without Conservation | | With conservation | | Water saving[2] |
|---|---|---|---|---|---|
| | lcd[1] | % | lcd | % | % |
| Bathing | 61.90 | 53.77 | 43.48 | 54.62 | 16.00 |
| Flushing WC | 29.70 | 25.80 | 15.00 | 18.84 | 12.77 |
| Brushing | 8.39 | 7.29 | 6.00 | 7.54 | 2.08 |
| Drinking | 1.63 | 1.42 | 1.63 | 2.05 | |
| Cooking | 4.71 | 4.09 | 4.72 | 5.92 | |
| Clothes washing | 6.87 | 5.97 | 6.87 | 8.63 | |
| Other activities | 1.92 | 1.67 | 1.92 | 2.41 | |
| Total water- use | 115.12 | 100 | 79.61 | 100 | 30.85 |

[1]lcd- litres per capita per day
[2]Calculated as percentage of the total water-use
**Source: Oduro-Kwarteng et al. (2009)**

By replacing existing showerheads with water efficient ones having flow rate of 9 litres per minute, about 18.42 litres of water per person per day could be conserved. Again, by replacing the existing WCs (14litres per flush) with water efficient WCs that use 7.5 litres per flush, about 14.7 litres of water per person per day could be conserved for flushing twice.

Water consumption could be minimised without constraining water users' need and preserve quality of life. This is an important characteristic for the development of a successful water conservation programme. The strategies involving the change of water users' practices and behaviours have proved to be difficult to enforce, but efforts to reduce water consumption by methods that are user accepted are better systems of water conservation. Retrofitting with water saving devices is user accepted, but it is considered by some people as too costly without justification based on economic analysis. Some responsible authorities overlook the long-term benefits of implementing a conservation programme and viewed initial costs as unjustifiably high. The current practice in the university is that old 14litres/flush WCs are replaced with 14litres/flush WCs instead of 7.5lires/flush WCs. The price of water in Ghana is expected to go up as existing tariffs are below cost recovery levels. It is prudent at this time to consider initiatives that focus on water conservation on the campus. An inventory of devices to be retrofitted was compiled. There were 371 showers, 442 lavatory faucets and 294 WCs in the halls of residence at the time of the study in 2005.

***Cost recovery period for installation of water efficient devices:*** The cost recovery period for recovering the replacement cost of retrofitting programme is of interest to authorities. The cost recovery period in years is the time taken for the cost to be defrayed. The assumptions for economic analysis of the water conservation are that: (1) water price will increase by 10% every year (water utility charge is GH¢0.45 per m3 of water), (2) interest rate on borrowed money from local bank for retrofitting is 20% per annum, (3) retrofitting to be implemented in 2007, (4) an amount of 65152 m3 per year, representing 30.85% potential annual water conserved was assumed to be constant during the period, and (5) the present worth of the costs of replacement and water savings were used for comparison, but in practice because of limited funds the replacement can be done in phases. The present worth values (PV) of the water savings from the year 2009 to 2015 were determined using the formula below.

$$PV_{ws} = \frac{FV_{ws}}{(1+r)^n}$$

Where $PV_{ws}$ is the present worth of water savings, $FV_{ws}$ is the future value of water savings, *r* is the interest rate and *n* is the number of years. Table 10 show the summary of calculations of the monetary value of water savings during the period.

**Table 10 Summary of calculations of monetary value of water savings**

| Year | water savings ($m^3$) | water savings (GH¢) | Present Value (PV) of Water Saving, (GH¢) | Cumulative PV of Water Saving (GH¢) |
|---|---|---|---|---|
| 2008 | 65,152.44 | 29,318.60 | 29,318.60 | 29,318.60 |
| 2009 | 65,152.44 | 32,250.46 | 26,875.38 | 56,193.98 |
| 2010 | 65,152.44 | 35,475.50 | 24,635.77 | 80,829.75 |
| 2011 | 65,152.44 | 39,023.05 | 22,582.79 | 103,412.53 |
| 2012 | 65,152.44 | 42,925.36 | 20,700.89 | 124,113.42 |
| 2013 | 65,152.44 | 47,217.90 | 18,975.81 | 143,089.23 |
| 2014 | 65,152.44 | 51,939.68 | 17,394.50 | 160,483.73 |
| 2015 | 65,152.44 | 57,133.65 | 15,944.95 | 176,428.68 |

*The quantity of 2008 water saving was assumed to be constant during the period*

**Source: Oduro-Kwarteng et al., (2009)**

The present value of the future water savings (2009 to 2015) was calculated to provide basis for comparing the cost of retrofitting and the savings. The cumulative amount of water savings was compared with the replacement cost of retrofitting to determine the payback period. The cost recovery period is the number of years for the cumulative present worth value of savings to equal the replacement cost. The intersection of the replacement cost and the cumulative water savings gives the cost recovery period (in years) for the retrofitting. The cost recovery period is six and half years.

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# Module 3

# POST-CONSTRUCTION MONITORING AND EVALUATION

**TITLE**

Post Construction Monitoring and Evaluation (PCM&E)

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**SUMMARY OF COURSE CONTENT:**

The manual discusses the concept, methods of data acquisition, analysis and reporting in post construction monitoring and evaluation.

**Unit 1** introduces participants to the concept of monitoring and evaluation, post construction monitoring and evaluation; both in a natural environment and in conflict situations. **Unit 2** discusses the laws, policies and institutional arrangements in post construction monitoring and evaluation. Also discussed in this unit are the building of capacity, bias and errors that are likely to affect the outcome of PCM&E results. **Unit 3** describes the purposes, scope and practices of PCM&E. **Unit 4** explains the issue of performance question, information needs and indicators used in PCM&E. In **Unit 5**, the components of a PCM&E, key steps in setting up a PCM&E programme and critical reflection on how people (i.e. stakeholders) can make sense out of the data generated for PCM&E is evaluated. Also discussed in the section are financial and human resources needed for a PCM&E programme. The section went further to discuss the terms of reference for a PCM&E programme, the purpose, scope and objectives of evaluation, team composition for evaluation, time frame required and cost of evaluation. Finally, the unit summarizes the components of a sustainability evaluation for a water and sanitation project. **Unit 6** examines information gathering, analysis and data management in PCM&E and the issue of of Quality Assurance and Quality Control are discussed. Thereafter, a typical water and sanitation monitoring programme is presented as a guide to participates on indicators and parameters to be monitored, issued to be defined and evaluation option.

Finally, a typical programme for a case study in PCM&E post construction monitoring and evaluation of the Kainji Dam in Nigeria is presented.

**THE NEED FOR PEOPLE TO PARTICIPATE IN THE TRAINING COURSE IN POST CONSTRUCTION MONITORING AND EVALUATION**

Once a developmental or construction project is completed, we should be able to respond to challenges and opportunities which the development of the project creates for community.
This can include being able to determine if the siting of the project is impacting positively, negatively or not impacting at all on the beneficiaries. Participants in this training course will be able to have clearer visions on principles of development effectiveness, construction project impacts on society and use lessons learnt for monitoring and evaluation to make decisions that result in positive post-construction impacts and contribute to human

development. Finally, it is essential to highlight that the stakeholders are engaged
Construction project proponents, sponsors and beneficiaries need to know what worked well and what did not, in order to suggest and implement necessary improvements, determine what remedial measures need to be taken to correct problems, and evaluate the cost implications of these corrections. A clear understanding of how post construction monitoring and evaluation will help participants (and ultimately stakeholders) to understand how to validate facility construction and operating capacity, guide refinement of components, operations, and documentation of the facilities effectiveness.

**TEACHING METHODS AND DIDACTICS**

i. Lectures/training workshops
ii. Discussion session
iii. Case studies
iv. Practical sessions where participants will work in groups aided by facilitators
v. Technical support/mentorship
vi. Higher Institutions will be encouraged to include Post Construction M & E in their curriculum for Civil Engineering, Geosciences, Water Resources, Environmental science and a combination of discussion

**TARGET GROUP/LEVEL OF TRAINING FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AND POST CONSTRUCTION M & E**

The training will be directed at the following categories of stakeholders

i. Policy makers including Managers, Directors and Chief Executives of public and private organizations involved in water resources, sanitation and environmental management
ii. Engineers, Scientists, Social Scientists, Geoscientists, Financial Managers, Law Officers and all other professionals involved in the provision of water supply and sanitation facilities
iii. Academics, Research officers and Graduate students in tertiary institutions
iv. Technicians and Technologists
v. Executives and senior personnel in Non Governmental Organization (NGO)

Representatives of beneficiary communities and community-based organisations (CBOs)

**Acknowledgement**

Special thanks to our Vice Chancellor Prof. O. G.  Oshodin for his overall leadership and support. The advice and encouragement of the coordinator of the Centre of Excellence University of Benin, Prof A. E Ebeigbe, was highly appreciated.

Members of the University of Benin CoE group who attended some of the meetings and made useful contributions are gratefully acknowledged, particularly for Prof. A. Ogbeibu, Dr J. Abolagba, Engr. Mrs Ngozi Ihimekpen and others.

Particular thanks go to the following people who participated in the development of the training programme including: Dr. O. C Izinyon, Mr. R. O. Ilaboya, Miss Animetu Seghosime and Mr. Iziengbe Inerhunwa.

In the preparation of this manual, extensive use was made of the United Nation Development Programme (UNDP) Handbook on Planning, Monitoring and Evaluation Results, Monitoring and Evaluation Orientation Course Manual, the International Federation of the Red Cross and Red Crescent Societies Project and Programme Monitoring and Evaluation (M&E) Guide.

For the case study work we are particularly grateful to all staff of the Kainji Dam Development Authority for making available, the post construction Inspection, Monitoring and Evaluation Programme.

The following people who helped draft the manuscripts are also acknowledged: Amaka Precious Obijiaku , Zita Chinenye Ezeokafor, Courage Aleburu, Dominic Igboenyesi, Ofiare Osakpamukhoko William and Juliet Akpejiori.

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# 1.0 INTRODUCTION AND OVERVIEW OF POST-CONSTRUCTION MONITORING AND EVALUATION

## 1.1 Background

Many construction development projects in African countries and other developing countries have been characterized by poor performance. Targeted goals in urban and rural water supply and sanitation for both human and rural dwellers in developing countries have not been realized as a result of poor project implementation, including poor quality construction and lack of policies that provide for the monitoring and evaluation of the success or failure in the implementation of these projects.

Post construction monitoring of water and sanitation system is intended to provide information on the effectiveness of a completed project and includes measures for determining the success of the project with respect to meeting the set goals. The monitoring programme is measured in terms of quantifiable indicators which track implementation of set goals and progress made with respect to project implementation.

As part of measures to verify water quality compliance it is necessary to carry out a post construction monitoring and evaluation plan.

A water quality compliance monitoring programme is part of a comprehensive post construction monitoring and evaluation plan. It must detail the monitoring protocols to be followed, including effluent and ambient monitoring, biological assessment, effluent toxicity testing and sediment sampling.

The post construction monitoring plan also addresses issues such as improvements to water conveyance systems to reduce water loss. The available water storage and treatment facilities should meet with both quantitative and qualitative requirements. Monitoring of quality includes assessment for Total Suspended Solids (TSS) and discharged or settled solids. Water quality must meet with standards set by the World Health Organisation (WHO) unless there is a national standard in place.

Inspection of the water infrastructures should be undertaken regularly (not just at end of-project) in order to ensure sustainability and long service life of the facility.

## 1.2 Definition of monitoring

Monitoring involves collecting, analysing, and reporting data on inputs, activities, outputs, outcomes and impacts as well as external factors, in a way that supports effective management. This is done regularly and systematically with a routine collection and analysis of information to track progress against set plans and check compliance to established standards. Monitoring can provide managers, decision makers and other stakeholders with regular feedback on progress in implementation and applicability.

The aim of monitoring should be to support effective management through reports on actual performance against what was planned or expected. Monitoring tools are essentially used for the early identification of problems and the solving of these problems as and when they occur. Monitoring is based on information collected before and during the operations and information required for monitoring may be entered into and analysed from a project management system (PMS), a management information system (MIS) or any other similar tool. Accuracy of the information collected for monitoring purposes, and ways to assess the accuracy of the information, are important aspects of monitoring.

Monitoring provides a measurement over time that indicates movement towards an objective or away from it. Monitoring can provide information about status and trends, but it cannot be used to determine causes and effects of impacts or problems. It helps inform management on decisions for the project/programme.

Aside from required minimum quality standards (WHO or construction) monitoring can also be applied to standards or guidelines from a land use plan; desired future conditions; historical conditions such as resettlement times; baseline information for a given year; or even a range of conditions or years. The standard may be for a specific site, an entire watershed or a land area such as a physiographic province or a continent.

## 1.3 Common types of monitoring

**Results Monitoring**: Results monitoring tracks effects and impacts to determine if the project/programme is on target towards its intended results (outputs, outcomes, impact) and whether there may be unexpected impacts (positive or negative).

**Process (activity) monitoring:** This tracks the use of inputs and resources, the progress of activities and the delivery of outputs. It examines how activities are delivered – the efficiency in time and resources. It is often conducted in conjunction with compliance monitoring and feeds into the evaluation of project impact. For example, a water and sanitation project may monitor whether targeted households receive septic systems according to project schedule.

**Compliance monitoring:** This ensures compliance with donor regulations and expected results, grants and contract requirements, local governmental regulations and laws, international and ethical standards. For example, a shelter project may monitor that shelters adhere to agreed national and international safety standards in construction or water quality compliance with WHO or National standards.

**Context (situation) monitoring:** This tracks the setting in which the project/programme operates, especially as it affects identified risks and assumptions, but also any unexpected considerations that may arise. It includes the field and the larger political, institutional, funding, and policy contexts that affect the project/programme. For example, a project in a conflict-prone area may monitor the security situation which could not only affect project success but endanger project staff.

**Beneficiary monitoring:** This tracks beneficiary perceptions of a project/programme. It includes beneficiary satisfaction or complaints with the project/programme, including their participation, treatment, access to resources and their overall experience of change. Sometimes referred to as beneficiary contact monitoring (BCM), it often includes a stakeholder complaint and feedback mechanism. It should take into account different population groups, as well as the perceptions of indirect beneficiaries (e.g. community members not directly receiving a good or a service).

**Financial monitoring:** This accounts for costs by input and activity within predefined categories of expenditure. It is often conducted in conjunction with compliance and process monitoring. An example would be monitoring the outputs of investment in a water project and the revenues from payment with water tariffs.

**Organizational monitoring:** This tracks the sustainability, institutional development and capacity building in the project/programme and with its partners. It is often done in conjunction with the monitoring processes of the larger, implementing organization. For example, the International Federation of Red Cross National Society's headquarters may use organizational monitoring to track communication and collaboration in project implementation among its branches and chapters.

Monitoring usually leads up to, and forms the basis for, evaluation but evaluation tools may also be used for monitoring.

## 1.4 Definition of evaluation

Evaluation is a systematic assessment of the strengths and weaknesses of the design, implementation and the results of completed or ongoing interventions. The two main purposes of evaluation are i) to improve future aid policy and interventions through feedback of lessons learned, and ii) to provide a basis for accountability, including the provision of information to the public.

Evaluation is a time-bound and periodic exercise that seeks to provide credible and useful information to answer specific questions which guide decision making by staff, managers and policy makers. Evaluations may assess relevance, efficiency, effectiveness, impact and sustainability. Impact evaluations examine whether underlying theories and assumptions were valid, what worked, what did not and why. Evaluation can also be used to extract crosscutting lessons from operating unit experiences and determining the need for modifications to strategic results frameworks. An example is evaluating the impact of water supply and sanitation projects on a rural community.

**Table 11 Common Evaluation Types**

| According to evaluation timing | According to who conducts the evaluation | According to evaluation technicality or methodology |
|---|---|---|
| **Formative evaluations** occur during project/programme implementation to improve performance and assess compliance.<br><br>**Summative evaluations** occur at the end of project/programme implementation to assess effectiveness and impact.<br><br>**Midterm evaluations** are formative in purpose and occur midway through implementation. For projects/ programmes that run for longer than 24 months, some type of midterm assessment, evaluation or review is required. Typically, this does not need to be independent or external, but may be according to specific assessment needs.<br><br>**Final evaluations** are summative in purpose and are conducted (often | **Internal or self-evaluations** are conducted by those responsible for implementing a project/programme. They can be less expensive than external evaluations and help build staff capacity and ownership. However, they may lack credibility with certain stakeholders, such as donors, as they are perceived as more subjective (biased or one-sided). These tend to be focused on learning lessons rather than demonstrating accountability.<br><br>**External or independent evaluations** are conducted by evaluator(s) outside of the implementing team, lending it a degree of objectivity and often technical expertise. These tend to focus on accountability.<br><br>**Participatory evaluations** are conducted with the beneficiaries | **Real-time evaluations (RTEs**) are undertaken during project/ programme implementation to provide immediate feedback for modifications to improve ongoing implementation.<br><br>Emphasis is on immediate lesson learning over impact evaluation or accountability.<br><br>RTEs are particularly useful during emergency operations.<br><br>**Meta-evaluations** are used to assess the evaluation process itself. Some key uses of meta-evaluations include: take inventory of evaluations to inform the selection of future evaluations; combine evaluation results; check compliance with evaluation policy and good practices; assess how well evaluations are disseminated and |

| | | |
|---|---|---|
| externally) at the completion of project/ programme implementation to assess how well the project/ programme achieved its intended objectives. All projects/programmes should have some form of final assessment, whether it is internal or external.<br><br>**Ex-post evaluations** are conducted at some time after the implementation to assess long term impact and sustainability. | and other key stakeholders, and can be empowering, building their capacity, ownership and support.<br><br>**Joint evaluations** are conducted collaboratively by more than one implementing partner, and can help build consensus at different levels, credibility and joint support. | utilized for organizational learning and change, etc.<br><br>**Thematic evaluations** focus on one theme, such as gender or environment, typically across a number of projects, programmes or the whole organization(e.g. the role of working in rural water supply)<br><br>**Cluster/sector evaluations** focus on a set of related activities, projects or programmes, typically across sites and implemented by multiple organizations (e.g. National Societies, the United Nations and NGOs).<br><br>**Impact evaluations** focus on the effect of a project/ programme, rather than on its management and delivery. Therefore, they typically occur after project/ programme completion during a final evaluation or an ex-post evaluation. However, impact may be measured during project/ programme implementation during longer projects/ programmes and when feasible. |

**Source: Adapted from IFRC and RCS guide (2011)**

## 1.5 Monitoring and evaluation (M&E) systems

A monitoring and evaluation system is a set of organisational structures, management processes, standards, strategies, plans, indicators, information systems, reporting lines and accountability relationships which enables national and provincial departments, municipalities and other institutions to carry their M&E functions effectively. In addition to these formal managerial elements are the organisational culture, capacity and other enabling conditions which will determine whether the feedback from the M&E function influence the organisation's decision-making and service delivery.

A monitoring and evaluation system serves to track the implementation and results of an intervention.

Table 12 Comparison between Monitoring and Evaluation

| Monitoring | Evaluation |
|---|---|
| Conducted: Ongoing & post project | Conducted: Periodically |
| Focus: Tracking performance | Focus: Judgment, learning, merit |
| Conducted internally | Conducted externally or internally |
| Answers the question: "What is going on?" | Answers the question: "Why do we have the results indicated by the monitoring data?" |

Source: Adapted from inside out for Samdi (2007)

## 1.6 M&E experience in developing countries

Many developing countries have made progress toward instituting M&E. With the growing global movement to demonstrate accountability and tangible results, many developing countries can be expected to adopt results-based M&E systems in the future.

Developing countries building their own results-based M&E systems face challenges both similar to and different from those of developed countries. Demand for and ownership of such a system may be more difficult to establish in developing countries. For example, a World Bank study found that "the key constraint to successful monitoring and evaluation of capacity development in Sub-Saharan Africa is lack of demand. Lack of demand is rooted in the absence of a strong evaluation culture, which stems from the absence of performance orientation in the public sector." (World Bank, 2000:15) With respect to demand, then, a minimum of interested stakeholders and commitment is necessary for such a system to be established and take hold in any country—whether developed or developing.

Other challenges in building an effective M&E system in developing countries include weak political will and institutional capacity, difficulties in inter-ministerial cooperation and coordination, lack of sufficient governmental cooperation and coordination, coordination across multiple governmental levels and lack of Technical assistance and training for capacity and institutional development.

## 1.7 What is post-construction monitoring and evaluation?

Post construction monitoring is conducted to measure success of a project, which can be two-fold: 1) to meet criteria and guideline conditions and to measure the attainment of a project's specific objectives, and 2) to measure the performance of a project over time. It is important to build monitoring components into the final and post-project assessment phases of the project:

- Establish pre-construction monitoring components and locations of the project starting with baseline conditions that provide a standard against which to measure improvement.

- Pay particular attention to the components of the project that are most sensitive, weak and vulnerable. Monitor the high-risk sections early on - document their conditions before and after construction of the project.
- Determine and select a methodology to monitor the objectives,
- Define monitoring parameters, sampling frequency, sampling locations and analytical procedures. Documentation of structures (their size, length, slope, etc.) should also be part of the monitoring strategy.

It's a good idea to involve the project designer in the selection of monitoring parameters. In water resources projects the purpose of post construction monitoring and evaluation is to document system station, current operations and financial situation of the water managers, system maintenance records as well as quantifying users satisfaction.

This allows for identifying areas of operational improvement and threats to sustainability.

The major value of post-construction evaluation utilizes the evaluation findings as a basis for learning through feedback as well as an accountability index where necessary.

Evaluation in the context of the infrastructure environment, normally called "post-construction evaluation", should focus on the performance of a project in relation to a set of evaluation criteria. Too often evaluation research reports take the form of a catalogue of design mistakes without a clarifying context. Therefore, post-construction evaluation often poses a threat to the designer and client's professional reputations and can have cost implications. In this context, it is understandable why so few professionals are interested in having their structures evaluated; practitioners view researcher's requests to study their projects with caution. If post-construction evaluation research is to be welcomed by practitioners, it must be executed in a non-threatening way and result in a product that is truly of value to the designer and client.

## 1.8 Data collection for monitoring and evaluation

Once you've set project goals, you can begin developing a monitoring and evaluation plan to align with those goals. As part of the plan, you'll need to determine the best way to collect data on the specified measures. Issues to be addressed at this stage should include:

- Type of data to be collected.
- Method of data collection.
- Frequency and timing of collection.
- Personnel and other resources required for data collection.

Data sources generally fall into two main categories: Routine and non-routine. Routine data is collected continuously, e.g. tidal measurement, river or stream gauging, rainfall data etc. This routine data can often be assessed and used for project purposes. However because the data is not project specific, you will need to combine it with other measures to provide a richer picture of the project. Non routine data is collected less frequently for the purpose of monitoring and evaluating activities. Data may include surveys conducted with beneficiary communities or testing the water quality in filters provided through the project and is typically gathered by donors, end users or the implementing organization. With non-routine data, time and budget considerations can influence the specific tool and data collection method to be used.

The following table lists basic tools for developing a plan for data collection.

**Table 13 Basic Tools For Developing a Plan For Data Collection**

| Method/Tool | Description | Purpose / Objective |
|---|---|---|
| Direct observation | Data collected through directly observing activities, outputs, or impacts during a project site visit | Providing or observing direct services provision such as number of water points, or provision of trainings |
| Focus Groups/Interviews | In-depth interviews with beneficiaries- one-on-one interviews or focus group discussions-in which the interviewer/facilitator poses pre-set questions in order to collect specific information | Digging deeper to identify the impacts of a project via the experiences of the beneficiaries; qualitative data can be customized to specific needs. |
| Admin / Financial Records and Reports | Documents kept by the project management on project participation, activities and impacts for the use of project managers | Documenting and archiving key project information |
| Public Records | Documents held by the government, private entities, or other organizations that are available to the public | Quickly and inexpensively accessing to standardized information (often quantitative) |
| Questionnaires and Surveys | Specific question asked of individuals or groups in a beneficiary population in order to gather specific data such as attitudes, opinions, level of satisfaction | Gathering quantitative and qualitative data from a beneficiary or target group can be customized for specific themes and needs |
| Satellite Imagery | Digital data obtained from sensors carried in satellite or global positioning devices | Recording the location of activities implemented or events Examples include boreholes, dam sites, irrigation ditches, or |

| Method/Tool | Description | Purpose / Objective |
| --- | --- | --- |
| | | trainings in community locations, floods or droughts |
| Testing | Activity to determine a specific result, such as measuring water quality | Measurements of a specific parameter, providing quantitative data |

**Source: Adapted from UNDP Monitoring and Evaluation Handbook (2011)**

A non-exhaustive list of stakeholders that could be considered in a post-construction monitoring and evaluation plan include:

i. Project donors World Bank, State and Federal Government institutions, Local Government authorities
ii. Beneficiary communities and target groups.
iii. NGO's
iv. Civil Society
v. Media

## 1.9 Post construction monitoring and evaluation in conflict situations

Conflict situations are generally regarded as not being normal. Conflict situations are dynamic and the PCM&E Programme should be defined in such a way as to adjust to radical changes that take place under such circumstances.

Where there is a conflict situation with respect to trans-boundary watershed or river basin for example, the situation should be continuously analysed and monitored to ensure that the programme still remains relevant even in the changing situation. The changes that take place in this situation should be documented so that the monitoring and evaluation of the relevance and appropriateness of the water resource and sanitation development initiative takes into consideration the fluid situation in which the project was conceived and implemented. This will involve continuous situation and conflict analysis. Conflict sensitivity should be considered in all aspects of post construction monitoring and evaluation to ensure that the process of PCM&E is conducted in such a way as to reduce or at least not heighten tension between the contending parties. Security of personnel should be a key concern in ongoing risk analysis and should be continuously monitored and factored into the PCM&E activities.

The PCM&E process should be designed in such a way as to not exacerbate a conflict situation

## 2.0 LAWS, POLICIES AND INSTITUTIONAL ARRANGEMENT IN POST-CONSTRUCTION MONITORING AND EVALUATION

### 2.1 Public policies related to monitoring and evaluation

Government may have policies that require monitoring and evaluation (M&E) of activities and expenditure. Most donors, international financial institutions (IFIs), and non-governmental agencies have their own internal M&E policies. However, there may not be any policy that governs the reporting of project results by funding or supporting agencies to government or to the project beneficiaries.

Monitoring requires the right incentives or implementing environment to ensure its effectiveness. This can include the Government establishing protocols and guidelines for the collection and reporting of post-construction project data, in order to facilitate collection, consolidation, and analysis that can be used at project level and up to the national level. A regulatory system can assist government agencies to track the progress and the effectiveness of specific expenditures related to the projects and programs being carried out.

### 2.2 Institutional arrangements

There should be a specific institutional M&E system within sector planning or programming at national level which should clarify the mandates of the monitoring and evaluation entities, their responsibilities, and accountability measures for effective data collection and data management of public programmes and projects. This can require: establishing standard tools and templates, aligning organizational data with the national data collection and management, installing standards for monitoring and evaluating, and ensuring proper training is available for entities and their staff. There should be sufficient resources, including availability of skilled staff and financial resources, allocated for M&E. Statistical capacity is an essential component of building results based M&E systems. Information and data should be valid, verifiable, transparent, and widely available to the government and interested stakeholders—including the general public. This may be difficult for some governments that would prefer not to disclose and share data for political reasons or to hide corruption.

Technically trained staff and managers, and at least basic information technology, are also a must.

Independence is important for the integrity of the exercise. A secure reporting line for those responsible for carrying out evaluations and mechanisms to safeguard the independence of the evaluation function are key institutional arrangements that should be provided.

### 2.3 M&E standards and ethics

M&E involves collecting, analyzing and communicating information about people – therefore, *it is especially important that M&E is conducted in an ethical and legal manner, with particular regard for the welfare of those involved in and affected by it.* International standards and best practices help to protect stakeholders and to ensure that M&E is accountable to and credible with them. The following is a list of key standards and practices for ethical and accountable PCM&E:

- Utility: M&E must be useful and used.
- Feasibility: M&E must be realistic, diplomatic and managed in a sensible, cost-effective manner.
- Ethics and legality: M&E must be conducted in an ethical and legal manner, with particular regard for the welfare of those involved in and affected by the evaluation.
- Impartiality and independence: M&E should provide a comprehensive and unbiased assessment that takes into account the views of all stakeholders.
- Transparency: M&E activities should be open and transparent.
- Accuracy: M&E should be technically accurate, providing sufficient information about the data collection, analysis and interpretation methods so that its worth or merit can be determined.
- Participation: Stakeholders should be consulted and meaningfully involved in the M&E process when feasible and appropriate.
- Collaboration: Collaboration between key operating partners in the M&E process improves the legitimacy and utility of the evaluation.

## 2.4 The role of government departments in promoting useful M&E systems

- To provide adequate training for the custodians of the system and end-users including related IT responsibilities. Training for M&E is part of the institution's skills development strategy.
- To prepare appropriate HR practices such as recruitment in order to attract scarce M&E skills. An effective retention strategy is also crucial to maximize staff continuity and preservation of institutional memory.
- To ensure that M&E roles and responsibilities are included in job descriptions and performance agreements to link individual performance to the institutional M&E system. The institutional framework for reward and recognition should take M&E achievements into account.
- To promote an organizational culture that supports M&E. In other words, is the managerial culture defensive, blaming and dismissive of M&E findings? Or are M&E findings regarded as an opportunity to explore problems openly and engage in critical but constructive introspection? Much of this depends on the tone set by the political heads and senior officials of institutions.

## 2.5 Bias and error in PCM&E

M&E helps uphold accountability, and should therefore be accountable in itself. This means that the Post-construction M&E process should be accurate, reliable and credible with stakeholders. Consequently, an important consideration when doing M&E is that of minimizing the possibility of bias.

Bias occurs when the accuracy and precision of a measurement is threatened by the experience, perceptions and assumptions of the researcher, or by the tools and approaches used for measurement and analysis. Minimizing bias helps to increase accuracy and precision. Accuracy means that the data measures that which it is intended to measure. Similarly, precision means that data measurement can be repeated accurately and consistently over time and by different people.

As much as it is desired to eliminate bias and error in our measurements and information reporting, no post-construction monitoring and evaluation is completely without bias. Nevertheless, there are precautions that can be taken, and the first is to be familiar with the major types of bias encountered in post-construction monitoring and evaluation. They include:

a) **Selection bias:** This results from poor selection of the sample population to measure/ study. Also called *design bias* or *sample error*, it occurs when the people, place or time period measured is not representative of the larger population or condition being studied. It is a very important concept to understand because there is a tendency to study the most successful and/or convenient sites or populations to reach (which are often the same.
b) **Measurement bias:** This results from poor data measurement – either due to a fault in the data measurement instrument or the data collector. Sometimes the direct measurement may be done incorrectly, or the attitudes of the interviewer may influence how questions are asked and responses are recorded. For instance, household occupancy in a flood disaster response operation may be calculated incorrectly, or survey questions may be written in a way that biases the response, (e.g. "Why do you like this project?" , rather than "What do you think of this project?").
c) **Processing error**: This results from the poor management of data – miscoded data, incorrect data entry, incorrect computer programming and inadequate checking. This source of error is particularly common with the entry of quantitative (statistical) data, for which specific practices and checks have been developed.
d) **Analytical bias:** This results from the poor analysis of collected data. Different approaches to data analysis generate varying results e.g. the statistical methods employed, or how the data is separated and interpreted. A good practice to help reduce analytical bias is to carefully identify the rationale for the data analysis methods.

# 3.0 PURPOSE AND SCOPE OF POST-CONSTRUCTION MONITORING AND EVALUATION

## 3.1 Purpose of PCM&E

Post-construction monitoring and evaluation serves several purposes. In the absence of effective monitoring and evaluation, it would be difficult to know whether the intended results are being achieved as planned, what corrective action may be needed to ensure delivery of the intended results, and whether initiatives are making positive contributions towards human development.

Evaluation and monitoring systems can be an effective way to:

- Provide constant feedback on the extent to which the projects are achieving their goals.
- Identify potential problems at an early stage and propose possible solutions.
- Monitor the accessibility of the project to all sectors of the target population.
- Monitor the efficiency with which the different components of the project are being implemented and suggest improvements.
- Evaluate the extent to which the project is able to achieve its general objectives.
- Provide guidelines for the planning of future projects.
- Influence sector assistance strategy. Relevant analysis from project and policy evaluation can highlight the outcomes of previous interventions, and the strengths and weaknesses of their implementation.
- Improve project design. Use of project design tools such as the log frame (logical framework) results in systematic selection of indicators for monitoring project performance. The process of selecting indicators for monitoring is a test of the soundness of project objectives and can lead to improvements in project design.
- Incorporate views of stakeholders. Awareness is growing that participation by project beneficiaries in design and implementation brings greater “ownership” of project objectives and encourages the sustainability of project benefits. Ownership brings accountability. Objectives should be set and indicators selected in consultation with stakeholders, so that objectives and targets are jointly “owned”. The emergence of recorded benefits early on helps reinforce ownership, and early warning of emerging problems allows action to be taken before costs rise.
- Show need for mid-course corrections. A reliable flow of information during implementation enables managers to keep track of progress and adjust operations to take account of experience.

## 3.2 Scope of PCM&E

The scope of a PCM&E system refers to its scale and complexity. It can be highly complex with a variety of activities and requiring considerable expertise and resources such as in transbounday water resources projects, or it can be relatively simple, relying on internal resources and capacities such as rural water supply and sanitation projects. The complexity of a project/programme's design (e.g. how many and the type of outcomes it seeks to achieve) will have a significant impact on the scale and complexity of the PCM&E system. Some important considerations for the scope (size) of a PCM&E system include:

- ***The geographic scale*** of the project/programme area, including accessibility to programme areas. Example is a large scale reservoir and dam project
- ***The demographic scale*** of the project/programme, including specific target populations and their accessibility
- ***The time frame*** or duration of the project/programme, including any pre- and post-project M&E needs

## 3.3 PCM&E structures, information systems and processes

The structure for PCM&Es will differ from organization to organization. Some organizations may prefer a centralized, specialized M&E unit. Others may opt to decentralize M&E functions. Whatever the structure of the M&E function, it is important that it has sufficient visibility and authority in order to facilitate M&E system management, promote M&E findings for informing policy and programmatic decision-making and resource allocation.

When considering the acquisition of an electronic system to support PCM&E, it is crucial to consider whether the system's specifications support the roll-out of the institutions PCM&E strategy and if it can be integrated with the institutions existing systems. It should also have the capacity to be able to exchange information and data with systems external to the institution if necessary. The relationship of the M&E system to other electronic systems should ideally be documented in the institution's IT systems master plan. Options for software and hardware (network configuration) need to be well researched and the choices made on an informed basis.

## 3.4 The basic steps for PCM&E

The practice of post-construction monitoring and evaluation covers/entails the following steps:

- **Building Demands by Meeting Needs:** As noted above, M&E entails gathering and using information and knowledge in order to improve accountability and enhance service delivery. This cannot be successfully achieved unless an explicit, sustained effort is made to find out what information is needed to improve performance in terms of accountability and service delivery. Finding this out requires personal consultations with the key role players involved. Such consultations must be undertaken regularly and the findings reflected in institutional M&E strategies. Details regarding these consultations, such as interview dates and findings should be part of a PCM&E strategy.

- **A Central Repository:** Each institution's PCM&E strategy should identify a central point at which M&E outputs should be lodged and stored for ease of access and to ensure they are known about and to encourage their utilization. The core of a central PCM&E repository should be a reliable and easily accessible catalogue of studies and their findings and recommendations that is available to any interested party.
- **Follow Up:** The catalogue of PCM&E studies, findings and recommendations referred to above should be used periodically to check what follow ups have been done and whether M&E recommendations are being implemented
- **Knowledge Sharing:** Institutions and organisations need to find ways of sharing the knowledge and wisdom generated through their PCM&E processes. One ways of doing so is the use of M&E Forums which are being successfully used in some countries, although there are other mechanisms available, such as learning circles. The choice of mechanism should be noted in the M&E Strategy and its connection to institutional Knowledge Management or Learning Strategies should be clearly spelt out.

# 4.0 PERFORMANCE QUESTIONS, INFORMATION NEEDS AND INDICATORS IN POST-CONSTRUCTION MONITORING AND EVALUATION

## 4.1 M&E within a Logical Framework approach

The Logical Framework Approach (LFA) is a management tool designed to improve and streamline projects, making them more effective in realising their development objectives, including that of producing sustainable benefits. The LFA is used by most governments, multi-lateral and bi-lateral aid agencies and international NGOs to prepare sector development plans and/or project proposals.

It is the principal tool used for project design during the identification and formulation phases of the project cycle. Using the LFA during project identification phase helps ensure that project ideas are relevant, while during formulation it helps to ensure feasibility and sustainability. However, it must also be complemented by the application of other specific tools (such as Economic and Financial Analysis and Environmental Impact Assessment) and through the application of techniques which promote the effective participation of stakeholders.

In summary the LFA includes a hierarchy of inputs, activities and objectives, as well as the indicators, risks and assumptions about internal and external factors. This LFA approach finally helps to set out a hierarchy of project objectives and match them with a set of M&E criteria.

## 4.2 Performance questions

Working with performance questions to guide indicator analysis will provide a more integrated and meaningful picture of overall project achievements. Answering these questions requires descriptive analysis and quantitative information. Beginning with identifying performance questions makes it easier to recognize which specific indicators are necessary. Sometimes a performance question can be answered directly with a simple quantitative indicator. However, often the question can only be answered by a range of qualitative and quantitative information. Performance questions are needed for different levels project objectives but also for the project as a whole.

## 4.3 What to monitor and evaluate in post-construction

Monitoring and evaluation address issues of learning and accountability. This is valid in a pre and post-construction scenario. Therefore project design optimally should include defining what is necessary to be monitored and evaluated, and why, before designing the PCM&E program.

The OECD principles of evaluation (OECD, 1991) and the European Commission Result based Monitoring handbook (EC, 2012) agreed on the following M&E criteria for project performance:

- Relevance - how well a project addresses a real problem of the beneficiaries
- Impact - how and to which degree the project has contributed to the solution of the
- problem and to the achievement of the overall objective.
- Effectiveness - measures the degree to which the project's outputs have provided benefits and contributed to the project purpose.
- Efficiency - stands for how well the inputs are transformed into output and outcomes
- Sustainability - measures to the likelihood of a continuation in the stream of benefits produced by the project after the period of external support has ended.

## 4.3 General evaluation issues

As stated above the general issues to be evaluated are relevance, impact, effectiveness, efficiency and sustainability. Each of these has a direct relation to a specific level or levels of the intervention logic and the logical framework. Each of the evaluation issues and factors must be addressed in every evaluation. They can be divided in categories according to their importance in a specific evaluation.

The following are the basic OECD (1991) evaluation criteria definitions:

**Relevance**

This is the extent to which the aid activity is suited to the priorities and policies of the target group, recipient and donor. In evaluating the relevance of a programme or a project, it is useful to consider the following questions:

- To what extent are the objectives of the programme still valid?
- Are the activities and outputs of the programme consistent with the overall goal and the attainment of its objectives?
- Are the activities and outputs of the programme consistent with the intended impacts and effects?

**Impact**

Impact is the positive and negative changes produced by a development intervention, directly or indirectly, intended or unintended. This involves the main impacts and effects resulting from the activity on the local social, economic, environmental and other development indicators. The examination should be concerned with both intended and unintended results and must also include the positive and negative impact of external factors, such as changes in terms of trade and financial conditions. When evaluating the impact of a programme or a project, it is useful to consider the following questions:

- What has happened as a result of the programme or project?

- What real difference has the activity made to the beneficiaries?
- How many people have been affected?

**Effectiveness**

Effectiveness measures the extent to which an aid activity attains its objectives. In evaluating the effectiveness of a programme or a project, it is useful to consider the following questions:

- To what extent were the objectives achieved / are likely to be achieved?
- What were the major factors influencing the achievement or non-achievement of the objectives?

**Efficiency**

Efficiency measures the outputs -- qualitative and quantitative -- in relation to the inputs. It is an economic term which signifies that the aid uses the least costly resources possible in order to achieve the desired results. This generally requires comparing alternative approaches to achieving the same outputs, to see whether the most efficient process has beenadopted. When evaluating the efficiency of a programme or a project, it is useful to consider the following questions:

- Were activities cost-efficient?
- Were objectives achieved on time?
- Was the programme or project implemented in the most efficient way compared to alternatives?

**Sustainability**

Sustainability is concerned with measuring whether the benefits of an activity are likely to continue after donor funding has been withdrawn. Projects need to be environmentally as well as financially sustainable.

When evaluating the sustainability of a programme or a project, it is useful to consider the following questions:

- To what extent did the benefits of a programme or project continue after donor funding ceased?
- What were the major factors which influenced the achievement or non-achievement of sustainability of the programme or project?

## 4.4 Indicators

An indicator is a pre-determined signal that a specific point in a process has been reached or result achieved. The nature of the signal will depend on what is being tracked, and needs to be carefully chosen. In management terms, an indicator is a variable that is used to assess the achievement of results in relation to the stated goals/objectives. Therefore they enable reliable monitoring and evaluation of the project.

The joint identification of indicators by key stakeholders also helps to analyse what the project means to the stakeholders. Important points often emerge which may not have been recognised in the previous planning phase. Although indicators are established in the planning phase, they can be revised later during the following phases of the project. Indicators can be established to meet the requirements of an evaluation. It is often useful to identify several indicators for a single objective.

Additionally, an indicator must answer questions such as "How much?", "What?", "Who?", "For how long?" and "Where?". To answer these questions it is necessary to define how the indicator will be checked in practice. It is also important to define an optimal number of indicators, since too many, or too complex, indicators can be difficult and costly.

Indicators are established on different levels. Some indicators measure progress or changes in the project environment, others are used to monitor relevance, impact, effectiveness, efficiency, impact and risk.

**Table 14 Issues to be Monitored Using Indicators**

| Issues | |
|---|---|
| Overall Objectives | - Relevance of project<br>- Impact of project |
| Project purpose | - Extent of achievement of Project Purpose<br>- Effectiveness of project |
| Results | - Extent of achievement of results<br>- Sustainability of project |
| Activities | - Carrying out of activities<br>- Efficiency of activities |
| Means | - Delivery of means |
| Assumptions | - Changes in environment |

**Source: Adapted from UNDP Monitoring and Evaluation Handbook (2011)**

In order to monitor effectiveness and impact, indicators should give an "early signal" of progress towards the project purpose and the overall objective. As an example, indicators can be identified to measure whether the beneficiaries have access, are using, and are satisfied with the project services. This gives an indication that the project is offering relevant services and the project purpose is likely to be met.

Indicators are used continuously by the project management. The specification of indicators and their sources of verification provide the basis for project-specific monitoring and evaluation. In the opening stages of a project, the performance of *Baseline studies* are often useful for identifying indicators.

#### 4.4.1 Common Indicators in PCM&E

The PCM&E framework establishes a limited set of common indicators for each level of the hierarchy of objectives. These include:

- **Input indicators:** These refer to the budget or other resources allocated at each level of the assistance. Financial input indicators are used to monitor progress in terms of the (annual) commitment and payment of the funds available for any operation, measure or programme in relation to its eligible costs.
- **Process indicators:** measure what happens during implementation. Often, they are tabulated as a set of contracted completions or milestone events taken from an activity plan.
- **Output indicators:** These measure activities directly realised within programmes. These activities are the first step towards realising the operational objectives of the intervention and are measured in physical or monetary units.
- **Result indicators:** These measure the direct and immediate effects of the intervention. They provide information on changes in, for example, the behaviour, capacity or performance of direct beneficiaries and are measured in physical or monetary terms.
- **Impact indicators:** These refer to the benefits of the programme beyond the immediate effects on its direct beneficiaries both at the level of the intervention but also more generally in the programme area. They are linked to the wider objectives of the programme. They are normally expressed in “net” terms, which means subtracting effects that cannot be attributed to indirect effects.
- **Baseline indicators:** Baseline indicators are used in the strength, weaknesses, opportunities and threats (SWOT) analysis and the definition of the programme strategy. Baseline indicators reflect the situation at the beginning of the programming period and a trend over time. The estimation of impact should reflect that part of the change over time that can be attributed to the programme once the baseline trend and other intervening factors have been taken into account. Baseline indicators fall into two categories:
    - *Objective related baseline indicators*. These are directly linked to the wider objectives of the programme. They are used to develop the SWOT analysis in relation to objectives identified in the regulation. They are also used as a baseline (or reference) against which the programme’s impact will be assessed
    - *Context related baseline indicators*. These provide information on relevant aspects of the general contextual trends that are likely to have an influence

on the performance of the programme. The context baseline indicators therefore serve two purposes: (i) contributing to identification of strengths and weaknesses within the region and (ii) helping to interpret impacts achieved within the programme in light of the general economic, social, structural or environmental trends.

A list of quantifiable indicators that can be utilized in a typical Urban and Rural Water Supply Project are presented below:

A. Administration: Track implementation and progress made in respect to:
    - Restoration of part of the project environment to a desired natural state.
    - Length and Value of stream corridor restored or improved.
    - Area of additional wetlands created or enhanced by the project.
    - Habitat area restored
    - Annual solid materials removed from storm inlets.
    - Annual removal of debris from waterways.
    - Number of projects completed.
    - Maintenance effort expended
    - Private sector development plans reviewed
    - Constructed project progress compared to implementation schedule
    - Running sum of benefits
B. Performance Monitoring of Structural Elements
    - Deformation monitoring in embankments and gullies
    - Subsidence Monitoring
    - Tracking of the infilling and emptying of reservoir
C. Performance of Other Facilities
    - Water pollution control measurements
    - Permanent metering of water levels
    - Pumping station records
    - Continuous flow monitoring of water in the reservoir

# 5.0 PROGRAMME DESIGN IN POST-CONSTRUCTION MONITORING AND EVALUATION

## 5.1 Components of post construction monitoring and evaluation programme/system

The PCM&E system consists of four interlinked parts

- *Setting up* the PCM&E system. Identify the information needed to guide the project strategy; ensure effective operations and meet external reporting requirements. Decide how to gather and analyse this information and document a plan for the PCM&E system. The process of working out how to monitor and evaluate a project inevitably raises questions about the project strategy itself, which can help improve the initial design. Setting up the PCM&E system with a participatory approach builds stakeholders' understanding about the project and starts creating a learning environment.
- *Implementing* the PCM&E system means gathering and managing information. Information comes from tracking which outputs, outcomes and impacts are being achieved and checking project operations (e.g., activity completion, financial management and resource use). This phase can lead to problem solving and improving the initial PCM&E plan.
- *Involve* project stakeholders in reflecting critically. Once information has been collected it needs to be analysed and discussed by project stakeholders. This may happen formally – for example, during the annual project review workshop-. In these reflections and discussions, you will probably notice information gaps. These can trigger adjustments to the PCM&E plan to ensure the necessary information is being collected.
- Communication of PCM&E results. The results need to be communicated to the people who need to use it. Only then can you call the PCM&E system successful. This includes reporting to funding agencies but is much broader. For example, problems experienced by field staff need to be understood by their manager. Project progress and problems must be shared with project participants so you can identify solutions together. Reports to funding agencies need to balance successes and mistakes and, above all, be analytical and action-oriented. Some of those who are to use the information may have been involved in collecting data and/or analysing part of it. However, you need to plan how to inform those who were not involved.

## 5.2 Key steps in setting up the PCM&E programme/system

The six steps involved in designing a PCM&E system are:

1. **Establishing the purpose and scope** – why do we need PCM&E and how comprehensive should our PCM&E system be?
2. **Identifying performance questions, information needs and indicators** – what do we need to know to monitor and evaluate the project in order to manage it well?
3. **Planning information gathering and organisation** – how will the required information be gathered and organised?
4. **Planning critical reflection processes and events** – how will we make sense of the information gathered and use it to make improvements?
5. **Planning for quality communication and reporting** – how and to whom do we want to communicate what in terms of our project activities and processes?
6. **Planning for the necessary conditions and capacities** – what is needed to ensure our PCM&E system actually works?

A good project definition study will optimally include an indicative PCM&E framework that provides enough detail to enable budgeting and allocation of technical expertise, give an overview of how PCM&E will be undertaken, and guide project partners and staff during the start-up and implementation of the project.

Good monitoring and evaluation design during project preparation is a much broader exercise than just the development of indicators, and should include the following five components:

1. Clear statements of measurable objectives for the project and its components, for which indicators can be defined.
2. A structured set of indicators, covering outputs of goods and services generated by the project and their impact on beneficiaries.
3. Provisions for collecting data and managing project records so that the data required for indicators are compatible with existing statistics, and are available at reasonable cost.
4. Institutional arrangements for gathering, analyzing, and reporting project data, and for investing in capacity building, to sustain the M&E service.
5. Proposals for the ways in which M&E findings will be fed back into decision making.

## 5.3 Detail of a PCM&E plan

The table below shows the tasks for each step in taking the outline of a PCM&E Programme Design and designing the details that make it operational.

Table 15 Tasks needed when detailing the PCM&E plan/Programme based on a project appraisal report

| PCM&E Design Steps | Outputs in Project Definition (the PCM&E Framework) | Tasks during Project Start-up to Develop a Detailed PCM&E Plan |
|---|---|---|
| Establish the purpose and scope | Broadly defined purpose and scope of PCM&E in the project context | • Review the purpose and scope with key stakeholders. |
| Identify performance questions, indicators and information needs. | List of indicative key questions andindicators for the goal, purpose and output levels | • Assess the information needs and interests of all key stakeholders.<br>• Precisely define all questions, indicators and information needs for all levels of the objective hierarchy.<br>• Check each bit of information for relevance and end-use. |
| Plan information gathering and organising | Generally described information gathering and organising methods to enable resource allocation | • Plan information gathering and organising in detail (who will use which method to gather/synthesise what information, how often and when, where, with whom, with what expected information product).<br>• Check the technical and resource feasibility of information needs, indicators and methods.<br>• Develop formats for data collection and synthesis |
| Plan for communication and reporting | Broad description of key audiences and types of information that should be communicated to them to enable resource allocation | • Make a precise list of all the audiences, what information they will need, when they need it and in which format.<br>• Define what is to be done with the information- simply send it, provide a discussion for analysis, seek relevant feedback for verification, etc. |

| PCM&E Design Steps | Outputs in Project Definition (the PCM&E Framework) | Tasks during Project Start-up to Develop a Detailed PCM&E Plan |
|---|---|---|
| | | • Make a comprehensive schedule for information production, showing who is to do what by when in order to have the information ready on time. |
| Plan critical reflection processes and events | General outline of key processes and events | • Precisely detail which methods/ approaches are to be used, with which stakeholder group and for what purpose. |
| Plan for the necessary conditions and capacities | Indicative staffing levels and types, clear description of organisational structure of PCM&E, indicative budget | • Come to a precise definition of: the number of PCM&E staff, their responsibilities and their linkages, incentives needed to make PCM&E work, organisational relationships between key PCM&E stakeholders, the type of information management system to be established and a detailed budget. |

**Source: Adapted from UNDP Monitoring and Evaluation Handbook (2011)**

A clear framework, agreed among the key stakeholders at the end of the planning stage, is essential in order to carry out monitoring and evaluation systematically. This framework serves as a plan for post-construction monitoring and evaluation, and should clarify:

- What is to be monitored and evaluated
- The activities needed to monitor and evaluate
- Who is responsible for monitoring and evaluation activities
- When monitoring and evaluation activities are planned (timing)
- How monitoring and evaluation are carried out (methodology)
- What resources are required and where they are committed

## 5.4 Critical reflection processes and events for PCM&E

This section covers how people can be involved in making sense of the data generated by PCM&E processes and in assessing the implications for the project strategy and operations. This aspect of PCM&E is rarely given the attention it needs during programme design. Usually during start-up, you need to plan such processes in detail (what will be the focus, who will participate, will they be facilitated or self-managed, how will one process feed into others, etc.) and schedule when they will occur.

Critical reflection can occur formally and informally. Formally, it can be facilitated during project meetings, workshops with partners and primary stakeholders or as part of external evaluations. Informally, it can occur in ongoing discussions between project stakeholders.

**Table 16 Critical Reflection Schedule for a PCM&E Programme**

| **Critical Reflection Processes or Events** | **Purpose and Description** | **Whom to Involve** |
|---|---|---|
| **Participatory review of programme strategy** | Update the situation analysis, revise problems/visions, adjust objective hierarchy and assumptions | Representatives of intended primary stakeholders, staff of participant organisation, all programme staff, facilitator |
| **Development of PCM&E plan with stakeholders** | Assess different information needs, take stock of who is already doing what, agree on priority information areas, refine questions/indicators, decide on methods, agree on responsibilities | Representatives of intended primary stakeholders, staff of participant organisation, all programme staff, facilitator |
| **Field visits** | **Firsthand look at what is happening in the field**, informal chats about how activities are being implemented | Field staff, supervisors of field staff, programme director |
| **Annual programme review** | **Summary of key successes and problems, ideas** for changing programme activities/outputs and assumptions, review of implications for the programme logframe, identification of lessons learned about programme implementation, PCM&E system adjustment | Representatives of intended primary stakeholders, staff of implementing partners, all programme staff, facilitator |
| **Periodic review workshops of key programme components** | Focused discussion about the strategy and operations of key components to adjust the objective hierarchy, solve problems and identify lessons learned | Key stakeholders of the programme component: intended primary stakeholders, implementing partners, field and senior programme staff |
| **Preparation for supervision missions** | Explain the mission purpose, agree on what the programme and stakeholders would like to get out of the mission, identify who needs to prepare what before the mission, organise the logistics | Small group of primary stakeholder representatives, senior staff of the participant organisation, senior programme staff |

**Source: Adapted from UNDP Monitoring and Evaluation Handbook (2011)**

## 5.5 Resources for PCM&E

Inadequate resources lead to poor quality post-construction monitoring and evaluation. To ensure effective and quality monitoring and evaluation, it is critical to set aside adequate financial and human resources at the planning stage. The required financial and human resources for monitoring and evaluation should be considered within the overall costs of delivering the agreed results and not as additional costs.

### 5.5.1 Financial resources

Post-construction monitoring and evaluation should be estimated realistically at the time of programme design for monitoring and evaluation. While it is critical to plan for monitoring and evaluation together, resources for each function should be separate. In practice, each programme should have two separate budget lines for its monitoring and evaluation agreed in advance with partners. This will help stakeholders and partners to be more realistic in budgeting. It will also reduce the risk of running out of resources for evaluation, which often takes place towards the end of implementation.

Monitoring and evaluation costs associated with programmes can be identified relatively easily and be charged directly to the respective programme budgets with prior agreement among partners through inclusion in the programme budget or Annual Work Plan (AWP) signed by partners.

Sourcing and securing financial resources for monitoring and evaluation of outcomes or programmes can pose additional challenges, as there is not one programme where these costs can be directly charged. The most commonly observed financing mechanism is to draw resources together from relevant programmes. Some additional possibilities include:

- Create a separate monitoring and evaluation fund, facility or programme associated with an outcome or a programme to which all the constituent programmes would contribute through transfer of some programme funds. This facility could be located in the same entity that manages the outcome or programme.
- Mobilize funds from partners directly for an outcome or programme monitoring and evaluation facility.
- Allocate required funds annually for each outcome on the basis of planned costs of monitoring and evaluation from overall programme budget to the facility or fund.

It is important that stakeholders and partners consider the resources needed for monitoring and evaluation and agree on a practical arrangement to finance the associated activities. Such arrangements should be documented at the beginning of the programme to enable partners to transfer necessary funds in accordance with their procedures, which could take considerable time and effort.

### 5.5.2 Human resources

Human resources are critical for effective monitoring and evaluation, even after securing adequate financial resources. For high-quality monitoring and evaluation, there should be:

- Dedicated staff time: For effective monitoring and evaluation, staff should be dedicated for the function. The practices of deployment of personnel for monitoring vary among organizations. Some organisations have established monitoring and evaluation units with specific Terms of References (ToRs), dedicated skilled staff, work plans and other resources.
- Skilled personnel: Staff entrusted with monitoring should have required technical expertise in the area. Having a dedicated monitoring and evaluation specialist is essential. Where necessary, skill levels should be augmented to meet the needs and with ongoing investments in developing such capacity within the organisations as necessary.

Each monitoring and evaluation entity that functions at different levels, for example at the programme, programme or outcome level, should have a clear ToR outlining its role and responsibilities. In general, these responsibilities should include:

- Setting up systematic monitoring frameworks and developing an evaluation plan
- Meeting regularly with key partners and stakeholders to assess progress towards achieving the results
- Conducting joint field monitoring and evaluation missions to assess achievements and constraints.
- Identifying any lessons or good practices
- Reflecting on how well the results being achieved are addressing gender, and the interests and rights of marginalized and vulnerable groups in the society.
- Identifying additional capacity development needs among stakeholders and partners.
- Reporting regularly to the lead individuals or agencies for the particular result areas and seeking opportunities to influence policy and decision-making processes.
- Ensuring the quality of monitoring and evaluation work and providing guidance as needed.
- Assessing the relevance of the M&E framework on a regular basis based on emerging development priorities and changing context

### 5.5.3 Specific considerations for budgeting and financing for PC-Evaluation programme design

- Programme units should estimate and indicate financial requirements and financing means for each evaluation in the evaluation plan. When estimating the cost for an evaluation, the duration and scope of the evaluation should be considered. The duration of an evaluation will be determined by its purpose. An evaluation conducted in implementation, which tends to focus on programme or programme design issues, is apt to be less complex and entail a smaller scope, hence requiring less data than would a 'heavier' exercise conducted at the end of the programme or the programming cycle. The greater the complexity and scope of an evaluation, the longer time and more detailed work will be needed by the evaluation team to collect required data. This may increase evaluators' total fees. Programme units should be realistic in terms of the scope and complexity of the evaluation *vis-à-vis* available resources.

- In addition, the availability and accessibility of primary and secondary data (monitoring, regular reporting and evaluation) and data collection methods influence the cost of the evaluation exercise. In the absence of reliable data, the evaluators need to spend more time and resources to locate or generate information. The appropriateness of allocated resources should be assessed together with the commissioned external evaluators based on the work programme submitted by them.

#### 5.5.4 Key issues to be considered in costing an evaluation

##### 5.5.4.1 Evaluators and external advisers, and expenses related to their duties

- **Evaluation consultants and expert advisory panel members (if any)**
    - One evaluator or a team? How many in a team? What is the composition (national or international)?
    - How many days will be required for each consultant and adviser?
    - What would be the daily rate range for each one of them?
    - Any cost associated with hiring?
    - Are the advisory panel members paid (daily fees, honorarium)?
- **Travel requirements**
    - What types of travel expenses will be incurred? For example, how many times does the team need to travel to the country or field? What travel requirements exist for briefings, interviews with stakeholders, data collection activities, stakeholder meetings, etc.?
    - What would be the primary mode of travel (air, programme vehicle, etc.)? Is there a need for special modes of transportation due to accessibility and security considerations?
    - For how many days and what are the daily subsistence allowances?
- **Requirements for consultations with stakeholders**
    - Are there regular meetings with the steering committee members to discuss the progress of the evaluation?
    - Will there be a meeting with wider stakeholders to discuss the findings and recommendations of the evaluation? How many and who will be invited?

- What would be the cost associated with renting venues, and bringing in stakeholders (allowances and travel expenses) and refreshments?

**5.5.4.2 Data collection and analysis tools and methods**

- What are methods of data collection?
- If surveys and/or questionnaires will be used, what is the target population and area to be covered?
- What resources are required (fees for enumerators, including their travel expenses, etc.)?
- Is there a need for researchers to complete a detailed analysis of data collected?

**5.5.4.3 Supplies**

- What supplies are needed? For example, office supplies, computer software for data analysis, etc.

**5.5.4.4 Communication costs**

- What are the phone, Internet and fax usage requirements?
- If surveys or questionnaires are conducted, how will they be administered (mail, Internet, telephone, etc.)?

**5.5.4.5 Publication and dissemination** of evaluation reports and other products, including translation costs, if needed.

**5.5.4.6 Resources**

- Are there any resources allocated for incidentals?

**5.5.4.7 Evaluation**

- Are there partners for the evaluation? Is this evaluation cost-shared?

## 5.6 Engagement of stakeholders in PCM&E

The engagement of stakeholders continues to be relevant for monitoring and evaluation stages for the following reasons:

- The stakeholders, who set the vision and the prioritized results to realize that vision during the planning stage, have the best ideas on how the results would continue to remain relevant to them. They must therefore be involved in identifying the **information or feedback that is needed during implementation**, which determines the parameters for monitoring and evaluation.
- Having set the vision, priority results and initial parameters for monitoring and evaluation, the key stakeholders are best placed to ensure that the programmatic initiatives planned would deliver what was intended and the way it was intended.

Stakeholder participation in monitoring and evaluation can produce effective communication for various other objectives. These include: facilitate communication of ‘early wins’ to increase support and enlist engagement of those who are not yet engaged, ensure access of early products and services of initiatives for intended beneficiaries, mobilize additional resources to fill resource gaps, and ensure effective use of lessons learned in future decision making.

Stakeholder participation throughout the programming cycle ensures ownership, learning and sustainability of results. **Continued stakeholder participation in monitoring and evaluation cannot be assumed, it must be institutionalized**. Specific measures have to be built into programme and programme management processes to ensure continued and effective involvement of stakeholders.

## 5.7 Terms of reference (TOR) for Post-Construction Evaluation

In terms of evaluation methodology, the ToR should retain enough flexibility for the evaluation teams to determine the best methods and tools for collecting and analysing data. For example, the ToR might suggest using questionnaires, field visits and interviews, but the evaluation team should be able to revise the approach in consultation with key stakeholders, particularly the intended users and those affected by evaluation results.

The ToR should, at a minimum, cover the elements described below:

### 5.7.1 Background and Context

The background section makes clear what is being evaluated and identifies the critical social, economic, political, geographic and demographic factors within which it operates that have a direct bearing on the evaluation. This description should be focused and concise highlighting only those issues most pertinent to the evaluation. The key background and context descriptors that should be included are listed below:

- Description of the intervention (outcome, programme, project, group of projects, themes, soft assistance) that is being evaluated.
- The name of the intervention (e.g., project name), purpose and objectives, including when and how it was initiated, who it is intended to benefit and what outcomes or outputs it is intended to achieve, and the duration of the intervention and its implementation status within that time frame.
- The scale and complexity of the programme, including, for example, the number of components.
- The geographic context and boundaries, such as the region, country, landscape and challenges where relevant.
- Total resources required for the intervention from all sources, including human resources and budgets comprising donor and other contributions.

- Key partners involved in the intervention, including the implementing agencies and partners, other key stakeholders, and their interest concerns and the relevance for the evaluation.
- Observed changes since the beginning of implementation and contributing factors

### 5.7.2 Evaluation Purpose

The purpose section of the ToR explains clearly why the evaluation is being conducted, who will use or act on the evaluation results and how they will use or act on the results. The purpose should include some background and justification for why the evaluation is needed at this time and how the evaluation fits within the programme unit's evaluation plan. A clear statement of purpose provides the foundation for a well-designed evaluation.

### 5.7.3 Evaluation Scope and Objectives

This section defines the parameters and focus of the evaluation. The section answers the following questions:

What aspects of the intervention are to be covered by the evaluation? This can include the time frame, implementation phase, geographic area, and target groups to be considered, and as applicable, which projects (outputs) are to be included.

What are the primary issues of concern to users that the evaluation needs to address or objectives the evaluation must achieve?

### 5.7.4 Evaluation Questions

Evaluation questions define the information that the evaluation will generate. This section proposes the questions that, when answered, will give intended users of the evaluation the information they seek in order to make decisions, take action or add to knowledge. For example, outcome evaluation questions might include:

- Were stated outcomes or outputs achieved?
- What progress toward the outcomes has been made?
- What factors have contributed to achieving or not achieving intended outcomes?
- To what extent have stakeholder outputs and assistance contributed to outcomes?
- Has the partnership strategy been appropriate and effective?
- What factors contributed to effectiveness or ineffectiveness?

Evaluation questions must be agreed upon among users and other stakeholders and accepted or refined in consultation with the evaluation team.

### 5.7.5 Methodology

The ToR may suggest an overall approach and method for conducting the evaluation, as well as data sources and tools that will likely yield the most reliable and valid answers to the evaluation questions within the limits of resources. However, final decisions about the specific design and methods for the evaluation should emerge from consultations among the programme unit, the evaluators, and key stakeholders about what is appropriate and feasible to meet the evaluation purpose and objectives and answer the evaluation questions, given limitations of budget, time and extant data.

### 5.7.6 Evaluation Products (Deliverables)

This section describes the key evaluation products the evaluation team will be accountable for producing. At the minimum, these products should include:

- Evaluation inception report: An inception report should be prepared by the evaluators before going into the full-fledged data collection exercise. It should detail the evaluators' understanding of what is being evaluated and why, showing how each evaluation question will be answered by way of: proposed methods, proposed sources of data and data collection procedures. The inception report should include a proposed schedule of tasks, activities and deliverables, designating a team member with the lead responsibility for each task or product. The inception report provides the programme unit and the evaluators with an opportunity to verify that they share the same understanding about the evaluation and clarify any misunderstanding at the outset.
- Draft evaluation report: The programme unit and key stakeholders in the evaluation should review the draft evaluation report to ensure that the evaluation meets the required quality criteria.
- Final evaluation report.
- Evaluation brief.

### 5.7.7 Evaluation Team Composition and Required Competencies

This section details the specific skills, competencies and characteristics needed in the evaluator or evaluation team specific to the evaluation and the expected structure and composition of the evaluation team, including roles and responsibilities of team members.

The section also should specify the type of evidence (resumes, work samples, references) that will be expected to support claims of knowledge, skills and experience. The ToR should explicitly demand evaluators' independence from any organizations that have been involved in designing, executing or advising any aspect of the intervention that is the subject of the evaluation.

### 5.7.8 Evaluation Ethics

The ToR should include an explicit statement that evaluations will be conducted in accordance with the principles Ethical Guidelines for Evaluation and should describe critical issues evaluators must address in the design and implementation of the evaluation, including evaluation ethics and procedures to safeguard the rights and confidentiality of information providers, for example: measures to ensure compliance with legal codes governing areas such as provisions to collect and report data, provisions to store and maintain security of collected information and protocols to ensure confidentiality.

### 5.7.9 Implementation Arrangements

This section describes the organization and management structure for the evaluation and defines the roles, key responsibilities and lines of authority of all parties involved in the evaluation process. Implementation arrangements are intended to clarify expectations, eliminate ambiguities, and facilitate an efficient and effective evaluation process. The section should describe the specific roles and responsibilities of the evaluators, including those of the members of the team, the evaluation manager, the management of the commissioning programme unit and key stakeholders. The composition and expected roles and responsibilities of the Advisory Panel members or other quality assurance entities and their working arrangements should also be made explicit. In the case of a joint evaluation, the roles and responsibilities of participating agencies should be clarified. Issues to consider include: lines of authority; lines of and processes for approval; and logistical considerations, such as how office space, supplies, equipment, and materials will be provided; and processes and responsibility for approving deliverables.

### 5.7.10 Time Frame for the Evaluation Process

This section lists and describes all tasks and deliverables for which evaluators or the evaluation team will be responsible and accountable, as well as those involving the commissioning office, indicating for each the due date or time-frame (e.g., work plan, agreements, briefings, draft report, final report), as well as who is responsible for its completion. At a minimum, the time breakdown for the following activities should be included:

- Desk review
- Briefings of evaluators
- Finalizing the evaluation design and methods and preparing the detailed inception report
- Visits to the field, interviews, questionnaires
- Preparing the draft report
- Stakeholder meeting and review of the draft report (for quality assurance)
- Incorporating comments and finalizing the evaluation report

### 5.7.11 Cost

This section should indicate total amount and other resources available for the evaluation (consultant fees, travel, subsistence allowance, etc.) This is not a detailed budget but should provide information sufficient for evaluators to propose an evaluation design that is feasible within the limits of available time and resources. If the available amount is not sufficient to ensure the high quality of evaluation products, discussions can take place between the evaluators and the commissioning unit early on in the process.

### 5.7.12 Annexes

Annexes can be used to provide additional detail about evaluation background and requirements to facilitate the work of evaluators. Some examples include:

- Key stakeholders and partners: A list of key stakeholders and other individuals who should be consulted, together with an indication of their affiliation and relevance for the evaluation and their contact information. This annex can also suggest sites to be visited.
- Documents to be consulted: A list of important documents and web pages that the evaluators should read at the outset of the evaluation and before finalizing the evaluation design and the inception report.
- Schedule of tasks, milestones and deliverables: Based on the time frame present in the ToR, the evaluators should present a detailed schedule.
- Required format for the evaluation report

# 6.0 INFORMATION GATHERING, ORGANISATION AND STORAGE

## 6.1 Information gathering and data collection

It is necessary to develop a data collection strategy when starting a PCM&E plan including practical implications of gathering the required information, evaluation and monitoring the project's/programme impacts. During start-up, a critical task for all implementing partners is to assess what information can realistically be collected, given available human and financial resources.

For each information need or indicator, it must be established how the information will be collected and organised. For example, monitoring progress on irrigation infrastructure development may require that primary stakeholders and project staff check what infrastructure has actually been constructed and if it is working properly. This is relatively straightforward. However, monitoring the impact of the irrigation development – for example, in terms of changes in household income – requires a different method such as household surveys. This is a fairly time-consuming and expensive monitoring activity and one that does not make primary stakeholder participation easy. A different option can be village-led surveys and open discussions with impact flow diagrams about changes in daily life as a result of irrigation.

Not only will each indicator require choosing a different method, but for each indicator or information need there will usually be several options available: qualitative, quantitative and individual versus group-based methods. They range from simple record-keeping forms to agronomic assessments of yield changes, household surveys and participatory workshops. Each method has specific advantages and disadvantages in terms of cost, reliability of data, skill needed, ability to quantify results and value of information generated.

Particularly critical at the moment of method selection is knowing who will be involved in collecting, compiling and analyzing the collected data. Persons in charge of collecting this data should be involved in the decision making regarding the type and the way in which the data should be collected to guarantee a correct data collection and use. Where necessary, trainings should be provided to guarantee a proper data collection. Information also needs to be collated, perhaps summarised and certainly analysed by experienced people. As a general rule, data collection and analysis should be undertaken with those to whom the data, analysis and decisions pertain and, therefore, at the relevant level. Field staff may, for example, need to understand about project reach within their administrative division, whereas a project director may need to analyse project reach for the entire project area.

## 6.2 Primary data collection methods in PCM&E

There are different ways in which primary data can be collected, depending on the project needs, skills levels, time and budget. Examples of ways of collecting primary data include:

- Individual based – for example questionnaires, surveys, and interview
- Group based – for example focus groups and group interviews
- Observations

The various methods have different strengths and weaknesses related to the skills and resources required for their implementation. These are presented below:

### 6.2.1 Interviews:

The differences between structured, semi-structured and unstructured interviews is how questions are presented. The table below explains these differences:

**Table 17 Types of interviews**

| Structured | Semi – Structured | Unstructured |
|---|---|---|
| Useful when numerical information is needed. | Useful where some quantitative and some qualitative information or descriptive information is needed. | Useful to explore new or sensitive topics in depth. |
| Questions must be asked in a standard way. | Questions may be asked in different ways, but some questions can be standard. | More like a conversation – no standard questions, just topic areas. |
| All questions must be asked. | Questions can be left out and others added. | Follow (or ask) the respondent to establish what is important to discuss. |
| Most questions have pre-set answers to choose between. | Include a mix of types of question – some open and some closed. | Open- ended |
| Results easy to analyse. | Analysis is fairly straight forward. | Analysis requires time and skill. |
| Follow many of the same rules as questionnaires. | | Follow many of the same rules as focus groups. |

**Source: Adapted from South African Management Development Institute (SAMDI) M&E Training manual (2007)**

#### 6.2.1.1 Structured interviews

Structured interviews are conducted using questionnaires, i.e. a written list of questions, mostly closed ended, or pre-coded, which can be directly given or (if feasible) posted to respondents.

**Purpose**

Structured interviews are useful when:

- We need information from large numbers of respondents.
- We know exactly what information you need, which you have established through other research methods (e.g. interviews).
- The information you need is fairly straightforward, and is required in a standardized format.
- Respondents are able to read and write and are comfortable with filling in a questionnaire.

#### 6.2.1.2 Unstructured and semi-structured interviews

Unstructured interviews will consist of open-ended questions. Such questions are designed to probe and stimulate the respondent to think rather than just giving quick answers.

**Purpose**

Unstructured interviews are most useful when:

- We need to know about peoples' experiences or views in depth.
- We can rely on information from a fairly small number of respondents
- The issue is sensitive and people may not be able to speak freely in groups.
- Our respondents will not be able to express themselves fully through a written questionnaire.

#### 6.2.1.3 Focus Groups

A group interview, where six to 12 people are brought together for a discussion. It is not a series of individual interviews conducted in a group – the interaction between group members is part of the process and should be encouraged.

**Purpose**

Focus groups are useful when:

- You need in–depth information about how people think about an issue – their reasoning about why things are the way they are, why they hold views they do.
- You need guidance in setting framework for some larger-scale study, about what people see as issues for them.

### 6.2.2 Observations

Observation involves observing objects, processes, relationships, or people and recording these observations.

**Purpose`**

Observation is useful when the information we want is about observable things and/or we need to crosscheck peoples' accounts of what happens or what has happened.

**Table 18 Summary of common data collection methods used in PCM&E**

| Method | Description | Advantages | Challenges |
|---|---|---|---|
| Extant Reports and Documents | Existing documentation, including quantitative and descriptive information about the initiative, its outputs and outcomes, such as documentation from capacity development activities, donor reports, and other evidence. | Cost efficient. | Documentary evidence can be difficult to code and analyse in response to questions.<br>Difficult to verify reliability and validity of data. |
| Questionnaires<br>. | Provides a standardized approach to obtaining information on a wide range of topics from a large number or diversity of stakeholders<br>(usually employing sampling techniques) to obtain information on their attitudes, beliefs, opinions, perceptions, level of satisfaction, etc. concerning the operations, inputs, outputs and contextual factors of a initiative. | Good for gathering descriptive data on a wide range of topics quickly at relatively low cost.<br>Easy to analyse.<br>Gives anonymity to respondents. | Self-reporting may lead to biased reporting. Data may provide a general picture but may lack depth.<br>May not provide adequate information on context. Subject to sampling bias |
| Interviews<br>. | Solicit person-to-person responses to predetermined questions designed to obtain in-depth information about a person's impressions or experiences, or to learn more about their answers to questionnaires or surveys. | Facilitates fuller coverage, range and depth of information of a topic, information and results in topic area. | Can be time consuming.<br>Can be difficult to analyse.<br>Can be costly.<br>Potential for interviewer to bias client's responses |
| On-Site Observation | Entails use of a detailed observation form to record accurate information on-site about how a programme operates (ongoing activities, processes, discussions, social interactions and observable results as directly observed during the course of an initiative). | Can see operations of a programme as they are occurring.<br>Can adapt to events as they occur.<br>Can be difficult to categorize or interpret observed behaviours. | Can be expensive.<br>Subject to (site) selection bias. |
| Group Interviews | A small group (6 to 8 people) are interviewed together to explore in-depth stakeholder opinions, similar or divergent points of view, or judgments about a development initiative or policy, as well as information about their behaviours, understanding and | Quick, reliable way to obtain common impressions from diverse stakeholders.<br>Efficient way to obtain a high degree of range and depth of information in a short time. | Can be hard to analyse responses.<br>Requires trained facilitator.<br>May be difficult to schedule. |

| Method | Description | Advantages | Challenges |
|---|---|---|---|
| | perceptions of an initiative or to collect information around tangible and non-tangible changes resulting from an initiative. | | |
| Key Informants | Qualitative in-depth interviews, often one-on-one, with a wide range of stakeholders who have first-hand knowledge about the initiative operations and context. These community experts can provide particular knowledge and understanding of problems and recommend solutions. | Can provide insight on the nature of problems and give recommendations for solutions.<br>Can provide different perspectives on a single issue or on several issues. | Subject to sampling bias.<br>Must have some means to verify or corroborate information. |
| Expert Panels | A peer review, or reference group, composed of external experts to provide input on technical or other substance topics covered by the evaluation. | Adds credibility.<br>Can serve as added (expert) source of information that can provide greater depth.<br>Can verify or substantiate | Cost of consultancy and related expenses if any.<br>Must ensure impartiality and that there are no conflicts of interest. |
| Case Studies | Involves comprehensive examination through cross comparison of cases to obtain in-depth information with the goal to fully understand the operational dynamics, activities, outputs, outcomes and interactions of a development project or programme. | Useful to fully explore factors that contribute to outputs and outcomes. | Requires considerable time and resources not usually available for commissioned evaluations.<br><br>Can be difficult to analyse. |

**Source: Adapted from UNDP Monitoring and Evaluation Handbook (2011)**

## 6.3 Assessing secondary data

An important consideration for data sources is the availability of reliable secondary data. Secondary data is important to consider because it **can save considerable time and expense.** It can also be used to help triangulate data sources and verify (prove) primary data and analysis collected directly as part of the project/ programme.

**However, it is critical to ensure that secondary data is relevant and reliable**. As secondary data is not designed specifically for project/programme needs, it is important to avoid the trap of using irrelevant secondary data just because it is available. Check the relevance of secondary data for:

- Time period – does it cover the same time period during which you need data?
- Data variables – are the characteristics measured relevant for what you are researching?

Even if the data measures what you need, it is important to ensure that the source is credible and reliable. It is important to check that any data source (primary or secondary) is accurate (measures what it is intended to measure) and precise (the data measurement can be repeated accurately and consistently over time and by different people.)

## 6.4 Quantitative and qualitative data

There are two main types of information produced by the data collection process: qualitative and quantitative. The difference between the two is that quantitative data are numerical (for example amounts, proportions) and qualitative data gives information which can best be described in words, diagrams and pictures (for example descriptions of events, observed behaviours, direct quotations, maps, photos). Qualitative data explains what is being studied.

Quantitative data measures and explains what is being studied with numbers (e.g. counts, ratios, percentages, proportions and average scores) using structured approaches (e.g. coded responses to surveys) which provide precise data that can be statistically analysed and replicated (copied) for comparison. . Qualitative methods employs semi-structured techniques (e.g. observations and interviews) to provide in-depth understanding of attitudes, beliefs, motives and behaviours. They tend to be more participatory and reflective in practice.

**Quantitative data is often considered more objective and less biased than qualitative data –** especially with donors and policy-makers. Because qualitative data is not an exact measurement of what is being studied, generalizations or comparisons between data sets can be limited, as is the credibility of observations and judgments. However, quantitative methods can be very costly, and may exclude explanations and human voices about why something has occurred and how people feel about it.

Therefore, for an effective PCM&E, **a mixed-methods approach is often recommended that can utilize the advantages of both, measuring what happened with quantitative data** and examining how and why it happened with qualitative data. When used together, qualitative methods can uncover issues during the early stages of a project/programme that can then be further explored using quantitative methods, or quantitative methods can highlight particular issues to be examined in-depth with qualitative methods.

## 6.5 Preparing for surveys

Surveys are a common method of gathering data for PCM&E. Surveys can be classified according to the specific method used – e.g. in person, by mail, telephone, etc. They generally use interview techniques (questions or statements that people respond to), measurement techniques (e.g. infant's weight to determine nutritional status), or a combination of both techniques. Unless a complete population is to be surveyed, a sampling methodology (discussed above) is used.

Surveys can be characterized by being structured or semi-structured (as explained above). Another important distinction for surveys can be made based on the timing and function of the survey:

- A **descriptive survey** seeks to obtain representative data about a population at a single point of time, without making comparisons between groups (such as a one-off needs assessment).
- A **comparative survey** seeks to compare the results between groups – either the same population at two or more points in time (e.g. baseline-end line design), or two distinct groups at the same point in time (e.g. treatment and control groups).

**Whatever survey method is used, it is critical to understand how it affects the way in which sample sizes are calculated**. For example, descriptive surveys need to account for a margin of error when calculating the sample size, while comparative surveys require a power calculation to determine the best sample size.

## 6.6 Preparing specific data collection methods/tools

The M&E plan summarizes data collection methods and tools, but these still need to be prepared for use. Sometimes methods/tools will need to be newly developed but, more often, they can be adapted from existing versions.

The best practices for preparing data collection methods/tools will ultimately depend on the specific method/tool being considered. Recommendations on practical considerations in planning for data collection include:

- **Prepare data collection guidelines.** This helps to ensure standardization, consistency and reliability over time and among different people in the data collection process.

Double-check that all the data required for indicators is being captured through at least one data source.

- **Pre-test data collection tools.** This helps to detect problematic questions or techniques, verify collection time, identify potential ethical issues and build the competence of data collectors.
- **Translate data collection tools**. This ensures that the tools are linguistically accurate, culturally compatible and operate smoothly.
- **Train data collectors**. This includes an overview of the data collection system, data collection techniques, tools, ethics, culturally appropriate interpersonal communication skills and sharing practical experience in collecting data.
- **Address ethical concerns**. Identify and respond to any concerns expressed by the target population. Ensure that the necessary permission or authorization has been obtained from local authorities, that local customs and attire (clothing) are respected, and that confidentiality and voluntary participation are maintained. Also verify that institutional ethical requirements from project donors as well as international ethical standards are also reviewed in the context of the project.

## 6.7 Minimizing data collection costs

Data collection is typically one of the most expensive aspects of the M&E system. One of the best ways to reduce data collection costs is to reduce the amount of data collected. The following questions can help simplify data collection:

- Is the information both necessary and sufficient? Collect only what is necessary for project/programme management and evaluation. Limit information needs to the stated objectives, indicators and assumptions in the logframe.
- How reliable are secondary sources of data? As discussed above, secondary data can save considerable time and costs – as long as it is reliable.
- Is the sample size adequate and not excessive? Determine the sample size that is necessary to estimate or detect change and maintain that limit. Consider using stratified and cluster samples.
- Can the data collection instruments be simplified? Eliminate unnecessary questions from questionnaires and checklists. In addition to saving time and cost, this has the added benefit of reducing survey fatigue among respondents.
- Is it possible to use competent local people for the collection of survey data? This can include university students, health workers, teachers, government officials and community workers. There may be associated training costs, but considerable savings can be made by hiring a team of external data collectors, and with the advantage that local helpers will be familiar with the population, language, etc.
- Are there alternative, cost-saving methods? Sometimes targeted qualitative approaches (e.g. participatory rapid appraisal – PRA) can reduce the costs of the data collection, data management and statistical analysis required by a survey – when

such statistical accuracy is not necessary. Self-administered questionnaires can also reduce costs.

## 6.8 Data management

Data management is the process of managing data collection through its capture, storage and use. **Data management also refers to the processes and systems for how a project/programme will systematically and reliably store, manage and access PCM&E data**. It is a critical part of the PCM&E system, linking data collection with its analysis and use. **Poorly managed data wastes time, money and resources**; lost or incorrectly recorded data affects not only the quality and reliability of the data but also all the time and resources invested in its analysis, use and correction.

Data management entails:

- Continually assessing whether the information needs are met
- Managing data collection and ensuring data is captured on time
- Analysing and using the information on time
- Disseminating information and results

An important way of ensuring quality data, is to train those who will be collecting and capturing the information and if feasible involve them in the design of the data collection tools. Be specific and assign clear objectives and responsibilities.

### 6.8.1 Planning for Data Management

Data management should be timely and secure, and in a format that is practical and user-friendly. It should be designed according to the project/programme needs, size and complexity. Typically, project/programme data management is part of an organization's or project/programme's larger data management system and should adhere to established policies and requirements

**The following are seven key considerations for planning a PCM&E data management system:**

1. **Data format:** The format in which data is recorded, stored and eventually reported is an important aspect of overall data management. Standardized formats and templates (as provided in this guide) improve the organization and storage of data. Generated data comes in many forms, but is primarily:
   - Numerical (e.g. spreadsheets, database sets)
   - Descriptive (narrative reports, checklists, forms)
   - Visual (e.g. pictures, video, graphs, maps, diagrams)
   - Audio (recordings of interviews).

Data formats can be physical, such as written forms stored in an office filing cabinet, or electronic, such as a spreadsheet stored in a computer database (discussed below). Donors or key partners, such as government ministries, may define how the data should be recorded and stored.

2. **Data organization:** A project/programme needs to organize its information into logical, easily understood categories to facilitate easy access and use. Data is typically organized by one or more combinations of the following classifications:
   - By timing (e.g. month, quarter, year)
   - By location
   - By content or focus area (e.g. different objectives of a project/ programme)
   - By format (e.g. project reports, donor reports, technical documents).
3. **Data availability**: Data should be available to its intended users and secure from unauthorized use (discussed below). Key considerations for data availability include:
   - **Access:** How permission is granted and controlled to access data (e.g. shared computer drives, folders, intranets). This includes the classification of data for security purposes (e.g. confidential, public, internal, and departmental).
   - **Searches**: How data can be searched and found (e.g. according to keywords).
   - **Archival:** How data is stored and retrieved for future use.
   - **Dissemination**: How data is shared with others (see Section 2.4.2).
4. **Data security and legalities**: Projects/programmes need to identify security considerations for confidential data, as well as any legal requirements with governments, donors and other partners. Data should be protected from non-authorized users. This can range from a lock on a filing cabinet to computer virus and firewall software programs. Data storage and retrieval should also conform with privacy clauses and regulations for auditing purposes.
5. **Information Technology (IT)**: The use of computer technology to systematize the recording, storage and use of data is especially useful for projects/programmes with considerable volumes of data, or as part of a larger programme for which data needs to be collected and analysed from multiple smaller projects/ programmes. Some examples of IT for data management in M&E include:
   - Handheld personal digital assistants (PDAs) to record survey findings
   - Excel spreadsheets for storing, organizing and analysing data
   - Microsoft Access to create user-friendly databases to enter and analyse data
   - SharePoint, a web-based intranet to store, share and discuss PCM&E data
   - An integrated planning management system with an internet platform for inputting, organizing, analysing and sharing information.

   IT can help to reorganize and combine data from various sources, highlighting patterns and trends for analysis and to guide decision-making. It is also very effective for data and information sharing with multiple stakeholders in different locations. However, the use of IT should be balanced with the associated costs for the computers and software, resources to maintain and safeguard the system, and the capacity among intended users.

6. **Data quality control:** It is important to identify procedures for checking and cleaning data, and how to treat missing data. In data management, unreliable data can result from poor typing of data, duplication of data entries, inconsistent data, and accidental deletion and loss of data. These problems are particularly common with quantitative data collection for statistical analysis. Another important aspect of data quality is version control. This is how documents can be tracked for changes over time. Naming a document as "final" does not help if it gets revised afterwards. Versions (e.g. 1.0, 1, 2.0, 2.1, etc.) can help, but it is also recommended to use dates as well.
7. **Responsibility and accountability of data management**: It is important to identify the individuals or team responsible for developing and/or maintaining the data management system, assisting team members in its use and enforcing any policies and regulations. Also, for confidential data, it is important to identify who authorizes the release/access of data.

## 6.9 Data analysis in PCM&E

Data analysis is the process of converting collected (raw) data into usable information. This is a critical step of the M&E planning process because it shapes the information that is reported and its potential use. It is really a continuous process throughout the PCM&E cycle to make sense of gathered data to inform ongoing and future programming. Such analysis can occur when data is initially collected, and certainly when data is explained in data reporting.

Data analysis involves looking for trends, clusters or other relationships between different types of data, assessing performance against plans and targets, forming conclusions, anticipating problems and identifying solutions and best practices for decision-making and organizational learning. Reliable and timely analysis is essential for data credibility and utilization.

### 6.9.1 Developing a Data Analysis Plan for PCM&E

There should be a clear plan for data analysis. It should account for the time frame, methods, relevant tools/templates, people responsible for, and purpose of the data analysis. A data analysis plan may take the form of a separate, detailed written document, or it can be included as part of the overall PCM&E system – for instance, it can be captured in the PCM&E plan. In whatever way it is stated, the following summarizes key considerations when planning for data analysis in PCM&E:

- **Purpose of Data Analysis**: What and how data is analysed is largely determined by the PCM&E objectives and indicators and ultimately the stakeholders and their information needs. Therefore, data analysis should be appropriate to the objectives that are being analysed, as set out in the PCM&E plan. **Analysis of output indicators** is typically used for project/programme monitoring to determine whether activities are occurring according to schedule and budget. Therefore, analysis should occur on a regular basis (e.g. weekly, monthly and quarterly) to identify any variances or deviations from targets. This will allow project/programme managers to look for alternative solutions, address any delays or challenges and reallocate resources.

- **Analysis of outcome indicators** is typically used to determine intermediate and long-term impacts or changes.

**Table 19 Planning Data Management**

| How will Information be collected? | Who will collect the information? | When will Information be collected? | How and by whom will information be captured? | Who will analyse the information? | When will analysis take place? | Who will Produce the report/feedback? | When will the report be completed? | How and to whom will information be disseminated? | Who will disseminate the information? |
|---|---|---|---|---|---|---|---|---|---|
| Information collection tools and methods | Specify person (s) | Specify information | Protocol for information capturing<br><br>Specify person(s) | Specify person (s) | Specify date | Specify person (s) | Specify date | Specify reporting format for each stakeholder | Specify person (s) |

## 6.10 Quality assurance and quality control in PCM&E

Once a PCM&E system has been developed, two more steps remain. First, overall quality check of the system itself as designed is needed. Second, to accommodate changing information needs, skill levels and contexts as well as the refinements in project strategies and activities the system must be regularly updated.

This unit describes key components for writing useful and quality monitoring and evaluation reports to help projects managers, partners and stakeholders carry out effective **quality assurance of the evaluation and monitoring processes and products**.

Developing a quality PC-E design demands a thorough understanding of what is being evaluated (**the initiative and its context**) and making decisions on how key elements will contribute to valid and useful evaluation results. Key elements are:

- The **purpose** of the evaluation
- The **focus** of the evaluation, that is, the key questions that the evaluation seeks to answer
- The **sources and methods** for obtaining information that is credible and defensible
- The **procedures** that will be used to analyse and interpret data and report results
- The **standards** that must be reached for the initiative to be considered successful
- The **evidence** that will be used to indicate how the initiative has performed and demonstrate its results (outputs and outcomes).

A good quality PC-M report should answer to the following recommendations:

- Is the Monitoring Report easy to read and understand?
- Are the recommendations useful and realistic?
- What is the relevance and quality of the design?
- Are the recommendations going to be adopted? By whom? When?
- What aspects will require special attention in the future?
- What is the feedback from other project stakeholders?

An example of a structure for a Water Monitoring report is presented below:

<u>Monitoring of Water and Sanitation Programme Measures - ensure that people have sustainable access to water and sanitation by:</u>

- Increasing equitable community access to safe drinking water and basic sanitation.
- Strengthening the ability of communities to develop and maintain sustainable water and sanitation systems.
- Educating communities about safe water, sanitation and hygiene.
- Supporting studies relating to water and sanitation.

**Table 20 Monitoring Report example of Water and Sanitation Programme Measures**

| Measures | Definition | Measurement Options |
|---|---|---|
| Total number of direct beneficiaries | Direct beneficiaries=individuals who receive a clear and immediate benefit from project activities<br><br>Do not simply report on the number of individuals living in a specific community or region | Grant records and reports direct observation |
| Number and percentage change of people with access to improved drinking water supply | Improved sources of drinking water include:<br>Piped water into dwelling<br>Piped water to yard/plot<br>Public tap or standpipe<br>Tube well or borehole<br>Protected dug well<br>Protected spring<br>Rainwater<br>Unimproved sources of drinking water include:<br>Unprotected spring<br>Unprotected dug well<br>Tanker-truck<br>Car with small tank/drum<br>Surface water<br>Bottled water (considered to be improved only when the household uses drinking water from an improved source for cooking and personal hygiene) | Direct observation grant records and reports questionnaires and surveys public records |

# 7.0 CASE STUDY PROGRAMME FOR PCM&E OF KAINJI DAM, NIGERIA

## 7.1 Site description

Kainji Dam is located in Niger State at the confluence of the Niger and Sokoto River Dam. The Dam was constructed across the river Niger on Kainji Island. The Kainji Dam consists of a main dam and a saddle dam. The main dam is a concrete dam and the saddle dam is a rock filled dam whose purpose is to take overflow from the main dam in the event of over flooding.

The dam contains intake gates (penstocks) each with steel opening of 8.55 in diameter. It is these penstocks that water from the lake passes through to rotate the turbine and convert mechanical energy to electrical energy.

The dam's height from base to crest is 65.50m and the length is 8.05km. The dam has two navigational locks, upper and the lower, which allow free passage of barges from the upstream to the downstream of the dam.

The operation of the Kainji reservoir started in 1969 and by 1973 the reservoir had experienced its first drought circle.

The Kainji Reservoir, with its storage capacity of 12 billion cubic metres, was designed to store ¼ of the total average run off of 45 billion cubic metres of water inflow of the Niger with replenishing a ratio of 1:4. The Kainji reservoir stretches to 136km upstream at a maximum headwater elevation of 141.73m and is supplied with water from the catchment area and the head waters in Senegal, Guinea and Sierra-Leone. It has a total capacity of 15 billion cubic metres and covers an area of 480 square miles. Two types of water flow are received into Kainji reservoir, namely, the "White" and "Black" floods.

In reality, the operation of Kainji reservoir with its 12 billion cubic metres tends to have its initial normal annual impoundment at about mid-August, based on the presence of substantial inflows from Niger "White" flood.

The minimum permissible operating level of water in Kainji Dam is about 131metres. At the highest elevation of 141.73m the volume of water stored is 12 billion cubic metres. It is a yearly objective to fill the lake to the maximum level by the end of February when the 'Black' flood starts receding. The water level is maintained at this level as long as possible by adjusting plant discharge to be nearly equal to the inflow. This ensures adequate water storage for power generation. At the Kainji hydroelectric plant, hydrologists take measurements at several locations upstream of the lake along river Niger, especially at Jidere-Bode, for prediction of the flow characteristics.

## 7.2 The need for post construction monitoring and inspection of the dam

Dam monitoring and inspections programmes are needed in order to enhance the safety of the dams and appurtenant structures for the protection of life and properties during the operation of the dam.

Dam safety inspections are made to ensure proper operation and maintenance, safety conditions and and recommending remedial measures where necessary.

In many cases the remedial measures to be undertaken include redesigning, strengthening or construction of the embankment or spillways modification of operations, repairs as necessary or, in extreme cases, closure of the Dam site if the anticipated risk level is high.

## 7.3 Dam instrumentation

The purpose of dam instrumentation is to monitor the safety of the dam's embankment and the concrete structures operations, the overall structural stability of the Dam and its different components and give timely warning of an unusual conditions. The equipment currently employed in monitoring of the Kainji Dam consists of the following:

- Relief Wells: This is to allow for the reduction of seepage pressure in the soil foundation at the toe of the dam
- Stand pipes: These are to check the seepage pressure which could lead to piping or jeopardize the stability of the saddle dam through the foundation.
- Extension gauges: These are used to monitor deflection of the dam embankment and settlement of the dam embankment.
- Piezometers: Hydraulics Piezometers are used to monitor the pore pressure at the dam and they are usually embedded in the core materials of the rock fill dam. They may also be installed in the foundation and the embankment. Electronic Piezometers are also used in monitoring water pressure in the Dam foundation and embankment.
- Extensometers: These are used to monitor the swelling of the concrete structure due to attack in aggregate reaction in the concrete dam and across the spillway gate. The rod also monitors the deflection and structural change in the concrete.
- Plumb Line: Plumb Lines are installed in the Concrete Dam to measure the displacement of part of the structure relating to a fixed foundation level. At Kainji, they are installed in intake Block 1, 6 and 10, spillway galleries EL 365 and EL 278, service bay EL 345 and one inverted intake block 1.
- Seepage Weirs: The seepage observations allow for the detection and interpretation of changes in the rate and characteristics of flow and knowledge of past leakages at the Dam.
- Totalizing Weir: This is used to measure the total seepage water at the base of the saddle dam.

## 7.4 Dam inspection at the Kainji dam

Generally, four types of inspections are performed:

1. Formal technical inspections: Performed initially for the dams and on a regular basis (2 to 5 yrs) thereafter, depending on hazard classification and specifications.
2. Maintenance inspections: Performed on a regular basis (annually) formal technical inspections may be conducted in place of maintenance inspections.
3. Informal inspections, and
4. Special inspections.

## 7.5 Dam monitoring at Kainji

Maps, plans, and other sources were reviewed for dimensions and descriptions that will provide a clear picture of the location, makeup, and function of each part of the dam of special importance for the PCM &E are:

- Overall dimensions of the dam
- Spillway configuration and operation
- Outlet configuration and operation
- Drainage systems and outfall locations
- Location and detail of monitoring points
- Capacity tables for the reservoir
- Discharge tables for the outlet and spillway
- Location and capacity of inflow and outflow ditches
- Records of past inspections, monitoring, repairs, and operating problems
- Photographs of pertinent features or problems on the dam, taken annually and kept on file for comparison and reference.

The ten most commonly monitored conditions include the following:

1. Deformation or movements
2. Groundwater pressure
3. Water level
4. Seepage flow
5. Water quality
6. Temperature
7. Cracks and joints
8. Seismic activity
9. Weather and precipitation
10. Stress and strain

Conditions not on the list, such as concrete deterioration, soil erosion, and inadequate vegetation cover are also monitored with simple instruments, including hand measuring tools and imagery. The types of instrumentation currently located at the Kainji Dam are shown in Table 11 below.

**Table 21 Dam Instrumentation Equipment Categorized by Function**

| | |
|---|---|
| **1. Deformation**<br>Hand measuring tools<br>(Geodetic surveys/GPS) methods<br>Probe Extensometers<br>Fixed embankment extensometers<br>Subsurface settlement points<br>Fixed borehole extensometers<br>Inclinometers<br>Tiltmeter<br>Liquid level gages<br><br>**2. Groundwater pressure**<br>Open standpipe piezometer<br>Twin-tube hydraulic piezometer<br>Pneumatic piezometer<br>Vibrating wire piezometer<br>Electrical wire piezometer<br>Pressure cells<br><br>**3. Water level**<br>Observation well<br>Piezometers<br>Water level sensor<br><br>**4. Seepage flow**<br>Weirs<br>Parshall flumes<br>Catch containers and timer<br>Velocity meter<br><br>**5. Water quality**<br>Laboratory analysis<br>Sample jars and visual inspection<br>Turbidity meter<br>Turbidity sensor | **6. Temperature**<br>Thermistor<br>Thermocouple<br>Resistance temperature devices<br>Density thermometer<br><br>**7. Cracks and joints**<br>Hand measuring tools<br>Surveying methods<br>Joint meter<br>Portable crack measuring microscope<br>Dial gage<br>Mechanical scratch gage<br>Crack comparator<br><br>**8. Seismic activity**<br>Accelerometer<br>Peak acceleration recorders<br><br>**9. Weather and precipitation**<br>Precipitation gage<br>Wind gage<br><br>**10. Stress and strain**<br>Electrical Resistance strain gage<br>Vibrating wire<br>Hydraulic load cell<br>Embeddable strain gage<br>Stress gage and meter<br>Strain gage and meter |

Instrumentation is used in conjunction with other information gathering methods to complete the monitoring program for a dam. Some of these methods are listed below:

- Visual examination/inspection
- Video surveillance
- Photographs, including perhaps a series of photos from a particular vantage point
- Audio recordings
- Water quality sampling programs

- Limited duration data gathering programs, such as geotechnical and/or materials testing of in-situ or laboratory samples, self-potential testing, thermal monitoring, resistivity surveys, seismic reflection/refraction studies, ground penetrating radar, etc.
- Geologic exploration programs, involving drill holes, test pits, etc.
- Dam/reservoir operations data and reports

## 7.6 Layout of a formal technical inspection report

A formal technical inspection report includes at minimum the following components:

1. A title sheet that includes all of the following information:
- The name of the dam
- The state inventory identification number
- The county and river or stream where the dam is located
- The owner's and operator's names, addresses, and telephone numbers
- The date of inspection
- The name, address, registration number, and signature of the licensed professional engineer who is in charge of the inspection report
2. An executive summary.
3. A table of contents.
4. A background section that includes the history of construction including completion date, ownership, operation and any past modifications, problems, incidents and/or failures on the structure.
5. A project information section that includes all of the following dam specific information:
    - The geologic setting and general site conditions
    - The purpose of the dam
    - A description of the dam, spillway system, and other principal features, together with pertinent data
    - A summary of available design, geotechnical, maintenance, construction, repair, and alteration information
    - A reference to past inspection reports
    - A map that shows the location of the dam

6. A field inspection section that includes the following:
    - A Dam Inspection Report A description of the physical condition of all features of the dam and appurtenant structures, including the impoundment level, as they were observed during the field inspection
    - A description of the downstream area with special emphasis on existing hazards and changes from previous inspections

- Dated and identified photographs of the dam, its appurtenances, the downstream channel, and all deficiencies cited in the report
- Justification for increasing the overall condition rating and/or increasing the rating of a condition on any components from the previous inspection

7. A structural stability section that includes a visual assessment of the stability of the dam on the basis of available data, together with the observations of the field inspection and the results of any calculations performed including a summary description of pertinent available information, such as the following:
   - Geotechnical design data
   - Seismic considerations
   - Seepage
   - Slope stability analysis
   - Previous evaluations

8. A hydrologic and hydraulic section that includes a visual assessment of the adequacy of the spillway system based on available data, together with the observations of the field inspection and the results of any calculations performed including a summary description of pertinent available information, such as the following:
   - Hydrologic design data
   - Drainage area
   - Changes in the watershed
   - Floods of record
   - Previous evaluations

9. An operation and maintenance section that includes all of the following:
   - An assessment of operating equipment and procedures
   - Evaluation of the current maintenance plan
   - Recommended changes to operation and maintenance procedures

10. An emergency preparedness and security section.

11. An overall evaluation of the structure's condition, spillway capacity, operational adequacy, and structural integrity based on current inspection, past performance history, existing documentation and recent analyses.

12. Identification of deficiencies which could lead to the structural failure.

13. Recommendations with a schedule for:
    - Maintenance, repairs, and alterations to the structure to eliminate deficiencies, including a recommend schedule for necessary upgrades to the structure

- Further detailed studies or investigations
- An assessment of the adequacy of the current hazard potential classification if appropriate

14. Appendices that include all of the following:
    - Engineering plans of the dam, if available, or sketches of the dam and its principal parts, including a plan view and cross sectional views of pertinent features
    - Supplemental plans or sketches that depict any changes
    - Supporting documentation for any of the parts within this section

Depending on current regulatory requirements, a copy of the detailed inspection report may need to be submitted, along with the Dam Inspection Report.

## 7.7 What to look for in post construction monitoring

The features that the monitoring team should examine depend on the type of monitoring and inspection and the type of dam (embankment, concrete, timber). A formal technical inspection will involve visual inspection of all dam features and general features around the dam.

These features typically include:

- Embankment crest and slopes,
- Principal and emergency spillways,
- Outlets and drains, and
- Miscellaneous features in the watershed.

A maintenance inspection should include inspection of all the dam features. Informal and special inspections usually focus on specific features and do not necessarily cover all of the dam features. However, it is recommended that informal inspections are performed frequently and cover as much of the dam and its structures as possible. The need to view site-specific features should be considered in preparing for the inspection.

Typically, the individual features of a dam will be visually examined and physically measured to determine the condition and to verify conformance with design or plans. If data and plans are not available, the examination process will determine the characteristics, locations, and dimensions of the individual features. Modifications of features will be revealed during the examination. The relationship between the levels of the reservoir to the dam and its characteristics on the day of the inspection is significant. Some features may not be visible at higher water levels. Seepage areas or other potential problems may not be readily apparent during an inspection when the reservoir level is low. Generally, all instrumentation systems should be inspected. The inspector should evaluate the condition of monitoring devices and collect data when appropriate for inspection purposes. The type of features that may require visual inspection during the monitoring and inspection of the dam are listed in Table 12

**Table 22 Typical Features that May Require Visual Inspection**

| **Embankment Dams (earthfill, rockfill)** | **Spillways (earth, rock, structural)** |
|---|---|
| Upstream slope | Approach channel |
| Downstream slope | Inlets and control sections |
| Left and right abutments | Discharge conduit |
| Crest | Discharge channel |
| Upstream & downstream groins | Outlet structures and stilling basins |
| Downstream toe | Joints |
| Internal drainage outlets | Control features (gates, stoplogs, flash boards) |
| Riprap & other slope protection | |
| **Outlets & Reservoir Drains** | Trash racks and debris control |
| Inlet structures | Drains (pressure relief) |

| | |
|---|---|
| Discharge conduit<br>Discharge channel<br>Outlet structures and stilling basins<br>Joints<br>Control features (gates, stoplogs, valves, bulkheads, hoists)<br>Trash racks and debris control<br>Drains (pressure relief)<br>Erosion protection (riprap, vegetation, concrete, gabions)<br>Access | Side slopes<br>Sidewalls<br>Erosion protection (riprap, vegetation, concrete, gabions)<br>**General Areas**<br>Submerged areas<br>Mechanical and electrical systems (cables, generators, winches, etc.)<br>Watershed and tributary stream channels<br>Access<br>Slope reinforcing and retaining structures<br>Shoreline and hillsides<br>Instrumentation<br>Downstream hazard<br>Upstream development<br>Downstream channel obstructions<br>Reservoir area<br>Emergency power systems<br>Hydropower facilities |

The geologic features of the dam site such as abutments, foundations, and subsurface materials, are normally covered by the construction and cannot be directly examined. In order to evaluate geologic features, it is important to examine areas adjacent to both the dam and the reservoir for conditions which may indicate a problem. A complete review of all available geotechnical information for the dam is necessary to perform the monitoring and inspection properly. A geophysical investigation may be required if the subsurface conditions warrant further inspection.

When individual features of a dam are examined, the inspector should look for typical conditions that indicate a problem may exist. Visual observations may identify conditions of a serious nature that require immediate repairs, or other conditions that may indicate a minor problem that require only routine maintenance or monitoring. Findings from prior inspections can be used to identify conditions that existed previously. These findings are useful for comparison of the dam in its present state to denote any changes in the condition and its assessment.

The type of inspection will dictate the detail to which the conditions need to be evaluated. Access, seasonal and weather conditions, impoundment levels, and equipment availability may limit the evaluation. Specific conditions should be looked for following an extreme event such as an earthquake or major hydrologic event. The following paragraphs summarize the general types of conditions to look for.

## 7.8 Underwater investigation

### 7.8.1 Echo Sounding Survey

Conduct an echo sounding survey to determine riverbed topography in the left tailrace channel between the concrete dam and the tailrace highway bridge and produce a topographic map of the surveyed area to show the general bottom configuration around the spillway apron and the spillway bucket.

### 7.8.2 Diving Program

Conduct a diving program to inspect problem areas apparent from echo sounding profiling of the tailrace channel and spillways as well as the power intakes. For a better definition of the objective, the following observations are to be reported on and if possible supported with underwater video.

**a) Spillway Bucket and Apron**

- Deposits of stones and boulders
- Erosion of side walls
- Erosion of Angostura bath, concrete structure and epoxy coating
- Erosion on apron end (protection slabs), presence of free-construction steel, contact with natural riverbed.

**b) Stilling bath**

Apparent accumulation of bed load, 60m downstream of the axis of the Buckets; configurations of material, rubble pile.

**c) Powerhouse**

Tailrace/ draft tube contact below unit 5 and 6, especially to observe apparent drop in channel bottom.

**d) Left tailrace bridge**

- Left abutment: inspection of contact with river bottom and erosion.
- Right abutment: riverbed erosion at the foot of the pier, precise location and size of vertical crack at 10 to 20cm from the block edge on the riverside.
- Ground weir in channel just upstream of left bridge abutment: its stability and erosion.

**e) Powerhouse**

- Trash racks to intake gates: condition of steel structure, protection painting.
- Intake piers; condition of concrete.

**f) Navigation lock**

- Condition of concrete/ rock interface.
- Inspect debris accumulation upstream and downstream of the waiting berth.

## 7.9 Evaluation of monitoring instruments and system

- Inspect and assess the present condition of all the dam monitoring instruments.

- Obtain and analyse instrumentation data collected during period of inspection for comparison with those of immediate past years providing reasons for variations if any.
- Assess the response of the state of these devices. Recommend remedial measures.
- Inspect, operate and assess the present condition of the Piezometers De-airing equipment.

## 7.10 Fill dams

Conduct inspection of the dams namely - the right fill dam, the left fill dam and the saddle dam to determine:

- The degree of change in slope upstream and downstream if any and also of riprap displacement.
- Check the condition of the right and left abutments concrete dam junctions for probable structural defects.
- Inspect the crests and wave walls for cracking, damage, movement, erosion etc.

## 7.11 Concrete dam

- Inspect and assess the present condition of the concrete galleries to ascertain the stability of the structure.
- Inspect and assess the degree of calcification/alkali aggregate reaction (AAR) and blockage of the drain holes in all the galleries
- Check the condition of leakage at the right abutment of the concrete dam wall through a construction joint at EL.440ft.
- Inspect the condition of all construction and expansion joints.
- Check the condition of the crest
- Inspect the spillway for leakage when gate are in the closed position. Recommend `
- Investigate the condition of mastic filling at various joints of all concrete structures.

## 7.12 Navigation locks

Inspect thoroughly the condition of all exposed portions of both the upper and lower locks for deterioration or movement.

## 7.13 Triangulation/geodetic survey

Locate survey control points within, or in the vicinity of Kainji hydroelectric structure and, using them as reference points, determine the vertical and horizontal movements/displacements of the embankments and the concrete dam using differential GNSS method.

## 7.14 Plumbline micrometer microscope

The microscope measuring unit (micrometer microscope) performs the following functions:

- Measures displacements in dams, dam foundations and abutments.
- Measures deflection in two mutually perpendicular directions to be measured relative to fixed rods.

The measuresing instrument component is a travelling microscope with micrometer adjustment and vernier scale. It should have a travel of 165mm and read to 0.01mm and an overall weight of 11kg. The contractor must carry out readings with the instrument supplied to the satisfaction of the user's department.

**POST CONSTRUCTION MONITORING OF WATER RESOURCES PROJECT**

**Example of Dam Inspection Report Format**

| | |
|---|---|
| Facility Name and Address | |
| Date of Inspection | |
| Inspector Name and Phone Number | |
| Best Management Practice (BMP) | |

[Project Name]................. [Date].........

**BASIN/DAM EMBANKMENT**

☐ No additional maintenance is recommended at this time.

☐ At the time of the inspection, the dam was overgrown. The dam shall be mowed so that a more thorough inspection can be provided.

Comments: ______________________________________________

______________________________________________

☐ Bare areas were noted on the dam. These areas shall be planted with grass.

Comments: ______________________________________________

______________________________________________

☐ Trees were noted on the dam. These trees shall be removed and replaced with grass.

Comments: ______________________________________________

______________________________________________

☐ Shrubbery and other types of vegetation were noted on the dam. This material shall be removed and replaced with grass.

Comments: ______________________________________________

______________________________________________

☐ The compaction of the dam, in the area around the outlet structure and the connection of the principal spillway pipe to the riser, seemed inadequate (e.g., the dam provided little resistance to soil probing). This condition shall be monitored as it may lead to piping or excessive settlement.

Comments: ______________________________________________

______________________________________________

[Project Name]…………………… [Date]…………..

☐ Piping (loss of soil) around the outlet structure/principal spillway pipe was noted. These areas shall be repaired.

Comments: ______________________________________________

______________________________________________

☐ Erosion/Sloughing is noted on the dam. These areas shall be repaired

Comments: ______________________________________________

______________________________________________

☐ Areas of slope slippage, bulging, and/or excessive settlement were noted on the dam. These areas shall be repaired.

Comments: ______________________________________________

______________________________________________

☐ Fractures were noted in the dam. These areas shall be repaired.

Comments: ______________________________________________

______________________________________________

☐ Animal burrows were noted in the dam. These burrow holes shall be filled in.

Comments: ______________________________________________

______________________________________________

[Project Name]………………… [Date]………

**OUTLET STRUCTURE**

☐ No additional maintenance is recommended at this time.

Comments: ______________________________

☐ The normal pool orifice/inverted siphon is blocked. This blockage shall remove.

Comments: ______________________________

☐ The outlet structure is filled with excess material (debris, trash, rock,etc.). This material shall be removed. A top trashrack is/is not recommended (disregard if a trashrack is already present)

Comments: ______________________________

☐ The top trashrack/anti-vortex device is damaged. The outlet structure shall be repaired or replaced.

Comments: ______________________________

☐ The outlet structure is damaged/deteriorated. The outlet structure shall be repaired or replaced.

Comments: ______________________________

☐ Additional items/comments:

______________________________

[Project Name]…………..                                                                 [Date]…….

**EMERGENCY SPILLWAY**

☐ No additional maintenance is recommended at this time.

☐ At the time of the inspection, the emergency spillway was overgrown. The spillway shall be mowed so that a more thorough inspection can be provided.

☐ It appears that the emergency spillway was not installed in accordance with the approved drawings. The spillway shall be installed.

Comments: ______________________________________________

______________________________________________

☐ Bare areas were noted on the emergency spillway. These trees shall be removed and replaced with grass.

Comments: ______________________________________________

______________________________________________

☐ Trees were noted on the emergency spillway. These trees shall be removed and replaced with grass.

Comments: ______________________________________________

______________________________________________

☐ Shrubbery and other types of vegetation were noted on the emergency spillway. This material shall be removed and replaced with grass.

Comments: ______________________________________________

______________________________________________

☐ Erosion was noted on the emergency spillway. These areas shall be repaired.

Comments: ______________________________________________

______________________________________________

**EMERGENCY SPILLWAY CONTINUED**

☐ Additional items/comments:

[Project Name]…………….. [Date]………..

**PRINCIPAL SPILLWAY PIPE (PSP)**

☐ No additional maintenance is recommended at this time.

☐ The PSP is blocked. The blockage shall be removed.

Comments: ____________________________________________

______________________________________________________

☐ One or more joints of the PSP are leaking.

Comments: ____________________________________________

______________________________________________________

☐ One or more sections of pipe have settled to a point where the integrity of the dam may be threatened. These sections of pipe may need to be replaced.

Comments: ____________________________________________

______________________________________________________

☐ Additional items/comments:

______________________________________________________

______________________________________________________

______________________________________________________

______________________________________________________

[Project Name]………….. [Date]……..

**OUTFALL**

☐ No additional maintenance is recommended at this time.

☐ The outfall structure is undermined and/or is rusting/deteriorating. This structure shall be

repaired or replaced.

Comments: ______________________________________________

______________________________________________

☐ The outfall structure has separated from the PSP by more than three inches. This

structure shall be reattached to the PSP.

Comments: ______________________________________________

______________________________________________

☐ The outfall area is eroding. The outfall area shall be repaired and stabilized with

additional riprap (e.g. irregularly shaped stone) or a permanent soil liner (i.e., turf

reinforcing mat, articulated concrete block,etc.).

Comments: ______________________________________________

______________________________________________

☐ The outfall is blocked. This blockage shall be removed.

Comments: ______________________________________________

______________________________________________

☐ Additional items/comments:

______________________________________________

______________________________________________

______________________________________________

______________________________________________

[Project Name]………… [Date]……..

**IMPOUNDMENT AREA**

☐ No additional maintenance is recommended at this time.

☐ The water level is more than 6” below the design normal pool elevation as per plan.

Comments:

☐ The forebay/sediment basin/micropool/impoundment areas have silted in. These areas shall be cleaned out.

Comments:

☐ The forebay berm has eroded. The berm shall be repaired.

Comments:

☐ Bare areas were noted on the basin side slopes. These areas shall be stabilized.

Comments:

☐ Eroded areas (rills, channels,etc.) were noted on the basin side slope. These areas shall be

repaired and stabilized.

Comments:

☐ Algae has covered over 50% of the deep pool and shallow water areas, the algae growth shall be removed and controlled.

Comments:

**IMPOUNDMENT AREA CONTINUED**

☐ Additional items/comments:

[Project Name]………………… [Date]……….

**OTHER MAINTENANCE ITEMS**

Site Inspection Photographs Attached: ☐ Yes ☐ No

**Inspector:**

| Signature | Printed Name | Date |
|---|---|---|

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# Module 4

# ENVIRONMENTAL IMPACT ASSESSMENT

| | |
|---|---|
| **TITLE** | ENVIRONMENTAL IMPACT ASSESSMENT (EIA) |
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| **TEACHING PROFESSORS** | DR J.O EHIOROBO<br>DR O.C IZINYON<br>PROF. A.E. OGBEIBU |

**SUMMARY OF COURSE CONTENT:**

The manual has been designed to meet the basic needs of stakeholders in understanding the concepts, methodologies and application of Environmental Impact Assessment (EIA) in the development of water resources and sanitation projects. **Unit 1** introduces participations to the concepts of EIA, its aims and objectives, historical development, legal and institutional framework, scope of application and public involvement. In **Unit 2**, screening and scoping in EIA is discussed. The section is concluded with Establishment of Environmental Baseline. In **Unit 3**, Impact identification, prediction and evaluation are presented. The section is concluded with a typical impact analysis including impact identification, prediction and evaluation for a water project.

**Unit 4** discusses impact mitigation and impact management. The components of an environmental management plan, monitoring, auditing and evaluation are also presented in this Unit. The method generally adopted in EIA reporting is presented. The Unit concludes with a Trans-boundary EIA for water supply and sanitation EIA project. Finally, in Unit V a case study of Environmental Impact Assessment is presented using the Gurara Dam water supply EIA Project

**THE NEED FOR STAKEHOLDERS TO PARTICIPATE IN EIA TRAINNING**

Environmental Impact Assessment (EIA) is designed to serve as a planning and decision making tool. Since environmental concern is the main issue in an EIA, it is essential that projects proponents and beneficiaries be knowledgeable in the implementation of EIA. All stakeholders must be able to assess and examine thoroughly any risks for severe or unexpected damages due to construction of projects and how the effects of such damages can be minimized.

The impact or damage a project will have on people and the environment needs to be critically analysed. Knowledge in EIA implementation is also essential for improving the basis for decision making with respect to project location and implementation.

**TEACHING METHODS/DIDACTICS TO BE USED:**

- Lectures/Training workshops
- Discussion sessions
- Practical sessions where participants will work in groups aided by facilitators

**TARGET GROUP/LEVEL OF TRAINING FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AND POST CONSTRUCTION M & E**

The training will be directed at the following categories of stakeholders:

- Policy makers, Managers, Directors and Chief Executives of public and private organizations involved in water resources, sanitation and environmental management
- Engineers, Technical and Social Scientists,
- Academics, Researchers and Graduate students in tertiary institutions
- Technicians
- Non-Governmental Organization (NGOs) and other Civil Society Organizations (CSOs)
- Representatives of beneficiary communities

**ACKNOWLEDGEMENT**

Special thanks to our Vice Chancellor Prof. O. G. Oshodin for his leadership and support. The advice and encouragement of the coordinator of the Centre of Excellence, University of Benin, Prof A. E Ebeigbe, is highly appreciated.

Members of the University of Benin CoE group who attended meetings and made useful contributions are gratefully acknowledged; particularly Prof. A. Ogbeibu, Dr J. Abolagba, Engr. Mrs Ngozi Ihimekpen and others.

Particular thanks go to the following people who participated in the development of the training programme: Dr. O. C Izinyon, Mr. R. O. Ilaboya, Miss Animetu Seghisome and Mr. Iziengbe Inerhunwa.

We are particularly grateful to the Federal Ministry of Water resources for making available the Gurara water supply and transfer EIA report which was used as a case study for water resources EIA.

The following people helped type the manuscripts: Amaka Precious Obijiaku, Zita Chinenye Ezeokafor, Courage Aleburu, Dominic Igboenyesi, Ofiare Osakpamukhoko William, Juliet Akpejiori, Etinosa Eghrevba and Edmund Akwuba.

Finally, we wish to thank NEPAD for their moral support and the European Commission Joint Research Centre (JRC) for their financial and moral support to the Centres of Excellence in Water Science and Technology.

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## 1.0 INTRODUCTION

EIA as defined by Munn (1979) is the identification, prediction and assessment of the impact of proposed policies, programs, projects and operational procedures on the environment and on man's health and well-being. Canter (1996) had defined the EIA as an attempt to evaluate the consequence of a proposed action on each of the descriptors on the environmental inventory, while Heer and Hagerty (1977) defined an EIA as an assessment which consists of establishing quantitative values for selected parameters which indicate the quality of the environment before, during and after the action.

Doe (1989) defined an EIA as a technique and process by which information about the environmental effects of a project is collected both by the developer and from other sources and taken into account by the planning authority in forming judgement on whether the project should go ahead. In spite of the various definitions, an EIA can simply be regarded as a formalised procedure undertaken to identify the likely impacts of a project and propose remedial measures to reduce or eliminate them.

### 1.2 Nature and Purpose of EIA for Water and Sanitation Projects

An EIA is intended to predict, assess and evaluate the impacts of proposed project intervention on the environment. They are needed to ensure that environmental requirements are included in the project planning process. An EIA should be linked with the project cycle and as early as possible during the project identification phase.

EIAs for water resources and sanitation projects should be structured in such a way as to cover the life cycle of the project commencing from the screening phase down to environmental monitoring and compliance audit phase. A flow chart for a typical water and sanitation EIA process is presented in Figure 1. A more detailed EIA process flow chart is presented in Figure 2.

### 1.3 Historical Perspectives in EIA

The first major policy dealing with the issue of environmental quality was drafted in the United States of America (USA) in 1969 after two major oil spill disasters which led to unprecedented damages to aquatic and marine life (US Environmental Protection Agency, 1972)

These disasters led to the passing of the National Environmental Policy Act (NEPA) of 1969 which became effective from 1$^{st}$ January 1970.

These developments in the USA eventually led to the establishment of the United Nation Environmental Program (UNEP) in 1980. Since then many countries have adopted EIA processes into their decision making.

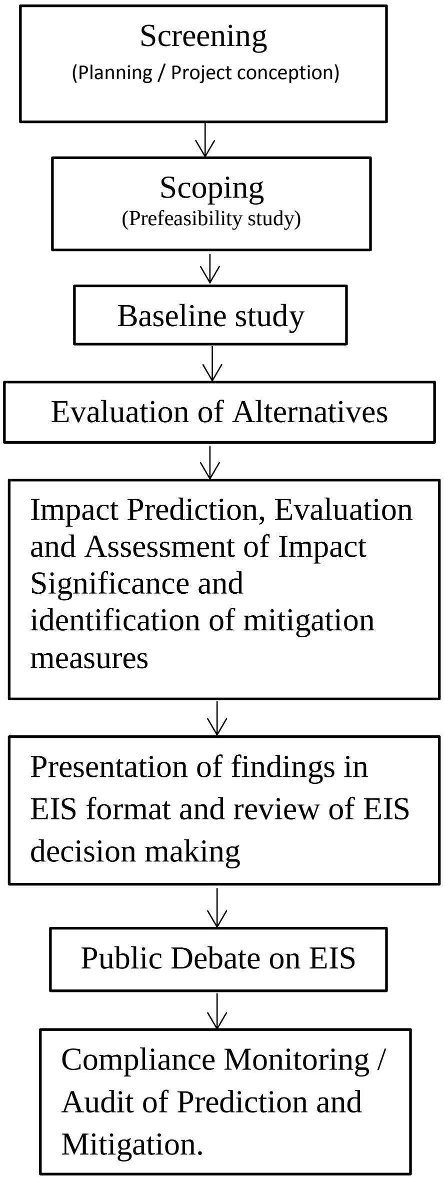


**Figure 1 Flow Chart for Typical Water and Sanitation EIA Process**

## 1.4 Aims and Objectives in EIA for Water Resources and Sanitation Projects

The aim of carrying out the EIA for water resources and sanitation projects is to identify all the significant negative impacts of the project and to propose mitigation measures that will reduce or eliminate the effects of those negative impacts.

EIA objectives include:

- To give details of the likely environmental condition if the project is not to be sited in such a location.
- To evaluate the impacts (positive and negative) of the proposed projects on the environment.

- To assess the cost of any measures to be put in place to improve the negative impacts.
- To plan and implement appropriate mitigation measures and ensure that these are built into the Environmental management plan.
- To assist in integration and sustainable management and development of water resources and sanitation related projects.

## 1.5 Legal and Institutional Framework in EIA

The overarching policy for EIA practice is usually through legislation, administrative order or in the form of a policy directive by government.

Environmental policies are being introduced in many countries and are normally supported by legislation. Some laws might require an EIA in certain types of sectors and related projects but sometimes EIA aren't mandatory by law but are still considered essential to be carried out by government agencies, NGOs, international organizations or donors.

In Nigeria, the practice of EIA is governed by legislation and guidelines which are published in Federal Official Gazette by the National Environmental Standard and Regulation Enforcement Agency (NESREA) and include the National / Sanitation and Water Control Regulation 2009, the National Environmental (watershed, mountainous Hilly and Catchment Areas) regulation 2009, the National Environmental (ground and surface water) Regulation 2011, National Environmental (wetlands, River bank and lakeshore) Regulation of 2009. In the oil and gas industry in Nigeria, the Department of Petroleum Resources (DPR) is responsible for setting out guidelines and standards for Environmental Impact Assessment and environmental protection compliance. Such guidelines and standard are set out in a document by the DPR Environmental guidelines and standard (EGASPIN, 2002).

Whether EIA are mandatory or not, it is important that an EIA considers the relevant policy and legislative environment relevant to the project in question. For example, at a local or regional level there may be particular regulations, customary laws and practices which; though they might not be part of environmental legislation, must be taken into account, as they will influence environmental aspects of any project.

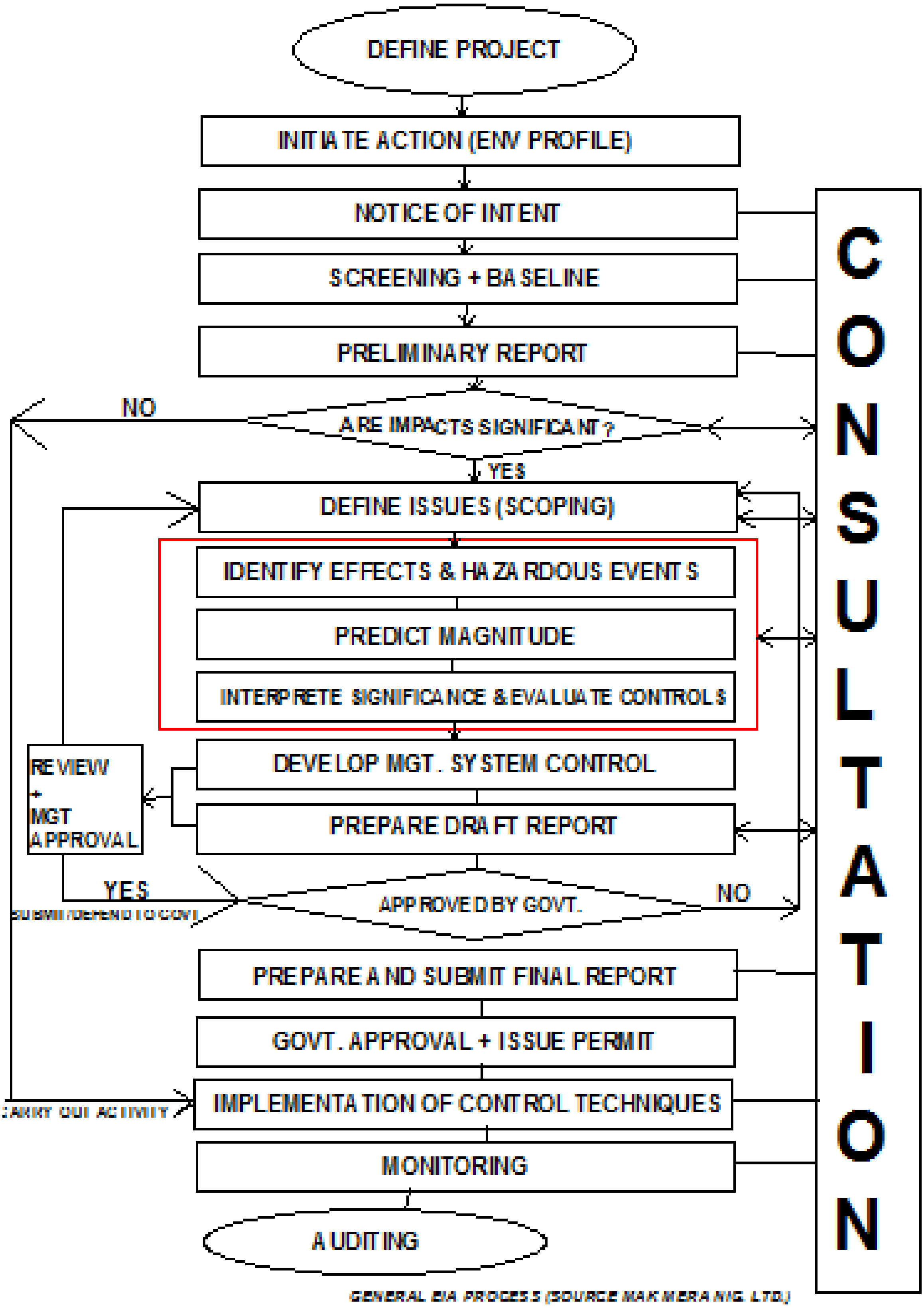


**Figure 2 Overall/General EIA Process**

**(Source: Makmera Nig Ltd, 1997)**

# 2.0 SCREENING AND SCOPING

## 2.1 Screening

Screening is the process used to determine whether a proposed project or activity requires an EIA and, if so, what level of environmental review is necessary. The EIA process kicks off with project screening and is undertaken during project identification and pre-feasibility studies to categorize whether or not a project requires a full EIA, partial EIA or no EIA. The threshold requirements for an EIA vary from country to country – some laws provide a list of the types of activities or projects that will require an EIA, others require an EIA for any project that may have a significant impact on the environment or for projects that exceed a certain monetary value. In some cases, particularly if the possible impacts of a project are not known, a preliminary environmental assessment will be prepared to determine whether the project warrants an EIA.

Certain projects will have less impact than others and therefore it is time consuming and a waste of resources for all proposed projects to undergo EIA. The number of impacts of a particular project that can be identified is often large but experience shows that only a relatively small proportion of project impacts will play an important role in a decision as to whether or not a project can proceed in an environmentally accepted manner. The screening process helps to examine the multitude of project impacts and to focus quickly on the presence or absence of significant environmental concerns in determining the scope of the assessment process (i.e. no assessment, partial assessment or full assessment).

The result of screening is an Initial Environmental Examination or Evaluation (IEE) document. Its conclusion is an evaluation of how the project will affect the environment, determine whether an EIA is required or not, and if so to determine the scope of the EIA. Figure 3 shows a typical screening flow chart.

According to the World Bank Screening procedure, environmental screening results for projects are classified into one of three EIA categories (World Bank, 1999):

- Category A projects require full EIA
- Category B projects require partial EIA
- Category C projects do not require EIA

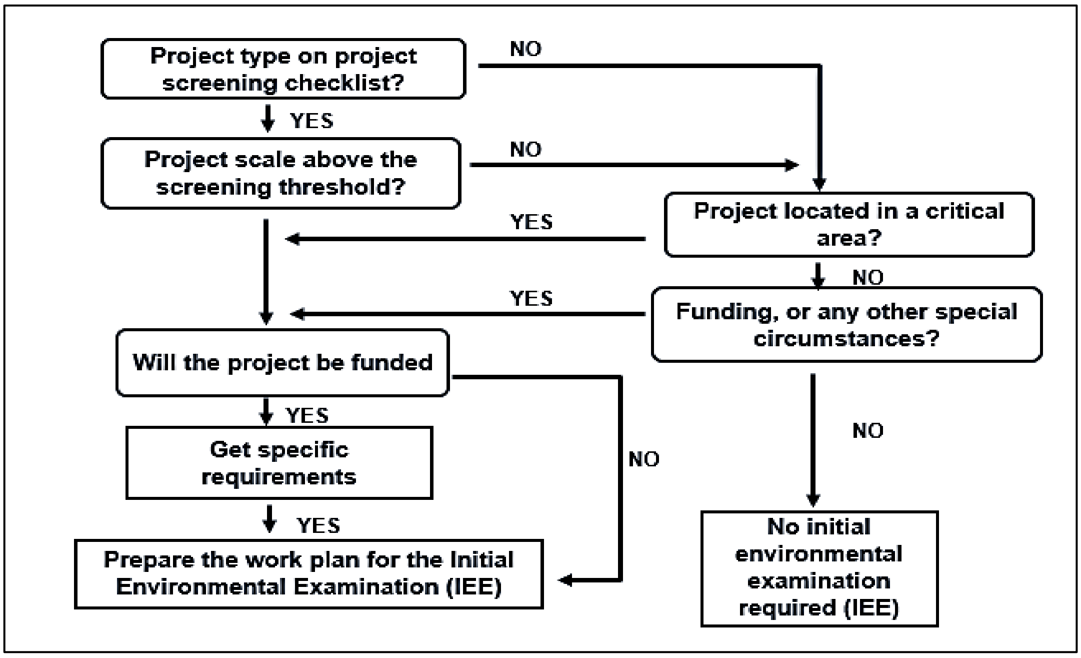


**Figure 3 Screening Flow Chart**

### 2.1.1 Purpose for Screening

There are three main purpose/objectives for carrying screening. They are as follows:

- To identify projects that may cause potential significant impacts
- To identify special conditions/analyses that may be required by stakeholders
- To categorize the project as:
    - Full-Scale EIA is required (i.e. Full Assessment – Category A)
    - Further environmental analysis is required (i.e. Partial Assessment – Category B)
    - No further environmental analysis is required (i.e. No Assessment – Category C)

### 2.1.2 Screening Methods, Tools and Techniques

The screening process commences with the development of preliminary project design criteria and the assembly of all available data for the project area. A combination of professional judgement, intuitive reasoning and relevant project experience is used to evaluate the magnitude, scale and duration of the environmental impacts and their interactions with the project (Arpel, 2010)

Tools and techniques employed in screening are:

- Assessor or decision-maker discretion
- Project lists
- Inclusive List with thresholds and triggers- listed projects which must undergo EIA
- Exclusive List - listed projects which are exempted from EIA

- Preliminary or initial EIAs
- Case-by-case examinations

In addition to the above listed tools and techniques, screening checklists can be used to determine what impacts, the proposed project will have on the environment based on information currently available; and screening questionnaires can be used to provide guidance to decide if a project requires an EIA or not. A typical screening checklist for a water resource project is shown in Table 1.

**Table 1 : Typical Screening Checklists for a Water Resource Project**

| **Check** | **Answer (Yes/No)** |
|---|---|
| Will the proposed project support irrigation schemes? | |
| Will the proposed project support rural water and sanitation schemes | |
| Will the proposed project involve urban water supply | |
| Will the proposed project involve small scale aquaculture | |
| Will the proposed project involve food processing | |
| Will the proposed project build or rehabilitate any structures or buildings | |
| Will the proposed project be located within or adjacent to any protected or sensitive areas? | |
| Will the proposed project depend on water supply from an existing water body or from diversion structures such as dams? | |
| Will the proposed project involve large scale groundwater abstraction? | |
| Will the proposed project involve a new surface/groundwater discharge or discharge relocation? | |
| Will the proposed project discharge water or generate runoff to any water body? | |

| | |
|---|---|
| Will the proposed project harvest significant amount of water resources? | |
| Will the proposed project affect the quality and/or quantity of surface water or groundwater? | |
| Will the proposed project result in production of solid or liquid waste during construction or operation? | |
| Will the proposed project increase runoff or raise flood levels upstream or downstream and cause soil erosion? | |
| Will the proposed project remove or modify vegetation at the site or within 50m of a water body? | |
| Will the proposed project channel a water body | |
| Will the proposed project line a water body with impervious materials? | |
| Will the proposed project be located in | |

## 2.2 Scoping

### 2.2.1 Purpose of scoping

Scoping is defined as a procedure for determining the extent and the approach of an Environmental Impact Assessment. Scoping is a critical stage early in the EIA process and it involves identifying the key environmental issues and impacts that can result from the project. It is designed to canvass views of several groups and project's stakeholders, particularly decision makers, the local population and the scientific community, who have an interest in helping to deliberate on the issues which should be considered in the project.

A major activity of scoping is to identify key interest groups, both governmental and non-governmental, and to establish lines of communication. Scoping is a stage that provides one of the first opportunities for members of the public or NGOs to learn about a proposed project and to voice their opinions. Scoping may also reveal similar or connected activities that may be occurring in the vicinity of a project, or identify problems that need to be mitigated or that may cause the project to be cancelled.

Scoping provides an opportunity to highlight the benefits of projects, while opportunities for environmental enhancement measures may also be identified

### 2.2.2 Methods and Techniques for Performing Scoping

Scoping should be carried out at an early stage of project planning, following completion of the Screening process but still during the feasibility stage of the project cycle.

Scoping should involve setting the boundaries of the baseline data collection for each project in terms of: geographical area to be covered, and in what detail; seasons and years to be covered; accuracy of the data to be collected; who should be involved; whether external expertise is required; what input is required by each person; and what further information is required. The method/style adopted should cover how the EIA fits into the Project Planning Cycle; and the logistical and practical requirements of the study.

The main EIA tools used in scoping are

- Baseline studies,
- Checklists,
- Matrices,
- Network diagrams.

**Baseline Studies** - Baseline studies during scoping involves gathering available data on the nature, location, type and scope of the project. It is used as a means for stakeholders to participate in the scoping process by commenting on the available data and their likely environmental impacts. Baseline data should be collected for a period long enough to cover all key environmental process that will occur at different times of the year.

**Checklists** – During scoping, checklists are employed mainly for organizing information on a project and for ensuring that all impacts that have significant environmental consequences are all taken into consideration. Before a checklist is used as a tool for scoping during an EIA, it should be reviewed by the EIA team. A typical scoping checklist for a water resource project is given below in Table 2.2.

**Matrices –** During scoping, matrices are used as a tool to determine the interactions between project activities and their potential environmental impact. The activities listed in the matrix should cover all the phases of the project.

**Networks** – Networks as a scoping tool are used for determining relationships that exist between project activities and their respective cumulative impacts on the environment.

These techniques (baseline studies, checklists, matrices and network diagram) collect and present knowledge and information in a straightforward way so that logical decisions can be made about which impacts are most significant. They are discussed further in section 3 of this manual.

It is important that decision-makers are consulted throughout the scoping process. A scoping plan should be prepared which includes: a list of stakeholders that are likely to be involved in the scoping process; methods to inform them about the proposal and ask their comments and concerns; and a determination of the project stages where their inputs will be required.

**Table 23: Typical Scoping Checklist for Water resource Project**

| Check | Change from the Present Situation (Yes/No) | Magnitude of Impact | Proposed Impact Measure |
|---|---|---|---|
| Will the proposed project result in changes in deposition or erosion or changes which may modify the channel of a river or stream or the bed of ant bay, inlet or lake? | | | |
| Will the proposed project substantially degrade water quality | | | |
| Will the proposed project contaminate public water supply | | | |
| Will the proposed project substantially degrade or deplete groundwater | | | |
| Will the proposed project cause leakage or seepage of contaminants into groundwater or soil | | | |
| Will the proposed project cause substantial flooding, erosion or siltation | | | |
| Will the proposed project result in changes in absorption rates, drainage patterns or the rate and amount of runoff | | | |
| Will the proposed project alter the course of flow of flood waters | | | |
| Will the proposed project change the amount of surface water in any water body | | | |
| Will the proposed project discharge into surface waters, or result in any alteration of surface water quality | | | |
| Will the proposed project alter the direction of or rate of groundwater flow | | | |
| Will the proposed project cause change | | | |

| | | | |
|---|---|---|---|
| in the quantity of groundwater either through direct addition or withdrawals | | | |
| Will the proposed project substantially reduce the amount of water otherwise available for public water supplies | | | |
| Will the proposed project expose people or property to water related hazards such as flooding | | | |
| Will the proposed project interfere with other proposed facilities that would be located in flood-prone areas | | | |
| Will the proposed project enhance impact of the proposed facilities that would increase off-site flood hazard, erosion or sedimentation | | | |
| Will the proposed project result in lowered water table, resulting in land subsidence with damage to infrastructure | | | |
| Will the proposed project lower water levels and decreased groundwater discharge. | | | |
| Will the proposed project cause over-exploitation of the water resource. | | | |
| Will the proposed project result in saltwater intrusion resulting in poor water quality. | | | |
| Will the proposed project cause lowering of water table, resulting in sinkhole or and reduced flow and habitat for ecosystems | | | |
| Will the proposed project result in water table fluctuation and change in aquifer capacity | | | |

### 2.2.3 Consultation and Participation of Stakeholders during Scoping

During scoping, consultation of key project's stakeholders to gather views on environmental aspects of the project is very important. The consultations should be initiated at the early stage of the project cycle to ensure that the comments and views of those directly affected by the project are not undermined and that stakeholders have the opportunity to comment on the merits, demerits and any other aspect of the proposed project.

As EIA is concerned with information, participation and transparency of decision making; stakeholder involvement consequently is inevitable for effective Environmental Impact Assessment and can take place in different ways which include: informing (one-way flow of information), consulting (two-way flow of information), or participation (shared analysis and assessment). Whatever techniques are employed for stakeholder consultation and participation, it should be suitable and appropriate to local circumstances. The EIA team should have the flexibility to choose and adapt various methods as time and local circumstances suggest. The use of a combination of stakeholder consulting and participatory techniques is encouraged. A list of employable techniques is given below:

- Public Notices
- Open public meetings/hearings on the projects,
- Delegation of authority to an affected community.
- Surveys
- Use of community representatives
- Workshops (Brain storming, Force field analysis, and Focus group discussions)
- Inviting written comments on proposed projects
- Making relevant documents available to interested stakeholders
- Establishing Project Information Centres (PICs)

Effective stakeholder consultation and participation will help in gathering relevant social, economic and environmental information that will improve the understanding of the context of the proposed project; clarify issues and improve project design. They also allow the participation of stakeholders in decision making process and foster a sense of local ownership.

### 2.2.4 Scoping Report

A written report on the results of the Scoping exercise should be prepared by the EIA team which will form the basis for preparing the ToR for the subsequent EIA study phase. The report should include, but not be limited to, the following: description of the project under consideration; description of alternatives; relevant legislation and institutional framework; details of stakeholders and their concerns; areas to be addressed by the EIA; extent of the environmental baseline; recommended impact identification; prediction and evaluation methodologies; resources needed to carry out the EIA; stakeholder consultation and participation methodology; list of reference documents and list of tasks undertaken by the EIA team.

#### 2.2.5 Significance/Benefits of Scoping

The importance of scoping lies in the fact that it can be used to detect impact at an early stage of the project cycle.

It helps to identify key issues to be addressed; additional project options; time and costs needed for EIA; mitigation measures; enhancement opportunities; assists the screening process; minimizes requests for further information at a later stage in the EIA process; and identifies likely significant effects (Environment Agency, 2002).

## 2.3 Establishment of Environmental Baseline

In an EIA, an environmental baseline is used to collect background data on biophysical, social and economic factors within the project site.

Baseline data provides information on current system and trends of environmental factors within the project area. They will also provide a means of monitoring to identify what environmental changes have taken place as a result of the development of the project.

The baseline study also includes a study of the original status of the environment in the area using the original data collected before the project is started. This study serves the purpose of a base reference against which the changes due to implementation of the project are measured (monitoring).

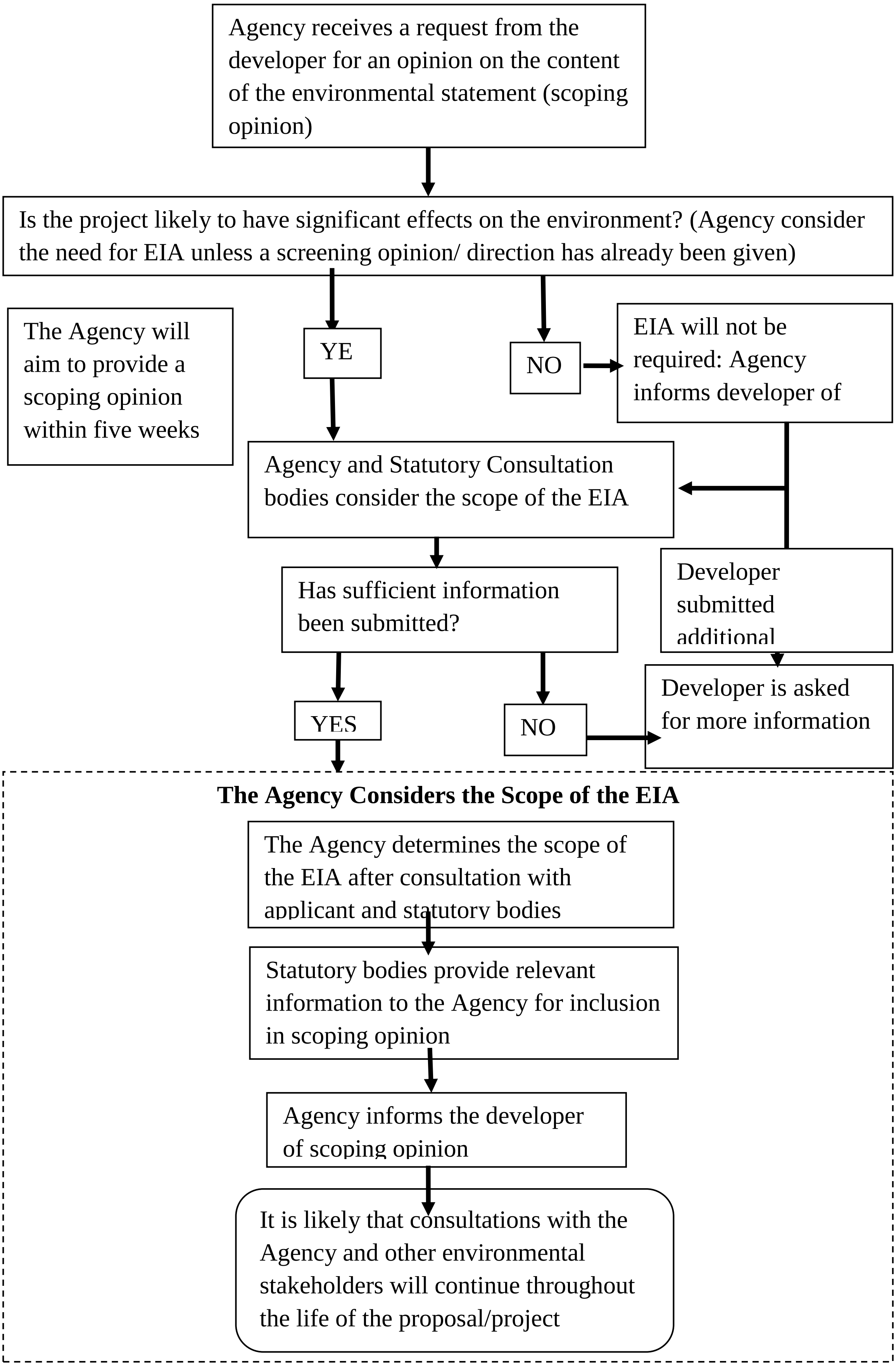


**Figure 4: Scoping Flow Chart (Source: UNEP, 2002)**

## 3.0 IMPACT IDENTIFICATION, PREDICTION AND EVALUATION

During impact identification, it is necessary to account for all important environmental indicators and ensure that all indirect and cumulative impacts are not left out. The nature of impacts should be taken into consideration in terms of their magnitude, severity, duration, frequency and level of risks. For most water supply and sanitation projects, the major impacts considered include the following:

**Impact on soil and topography:**

In this case, surface run off and erosion are likely to occur during construction, particularly on hill slopes toward river valleys. Soil erosion will take place during earth works, such as the clearing of a reservoir area with removal of vegetation cover.

**Impact on Hydrology and Water Quality**:

Impacts on hydrology and water quality can include:

- Water pollution due to leakages of oil, grease and other contaminants from construction plants and vehicles.
- Disruption of ground water flow and changes in water table.
- Disruption in surface water flow and changes in flow pattern.
- Flooding and water logging within the project area.

**Air pollution, Noise and Vibration of Machinery:**

There is often air pollution due to the exhaust gas from plants and vehicles as well as noise and vibration from construction plants and heavy vehicles on site.

**Ecological Impacts:**

The ecological impacts are likely to include:

- Impact on fish migration due to changes in water balance
- Impact on terrestrial flora and fauna as a result of loss in fragmentation and changes in habitats.
- Impact on aquatic flora and fauna as a result of water quality, quantity and changes in habitats.
- Impact on rare and endangered species
- Impact on biodiversity within the study area

**Social Economic Impact**:

In a water supply and sanitation project social economic impacts are likely to occur due to: changes in water usage such as irrigation for farming practices, other abstraction for commercial activities, impacts on local fisheries, relocation of affected populations and subsequent changes in the social fabric or structure of the community.

## 3.1 Impact Identification Method

Various methods of impact identification have been developed to provide an organized approach for impact analysis. The choice of a method to be adopted will depend on the project type, and the expected scope and magnitude of impacts.

In general, the most common methods of impact identification include

- Check lists
- Matrices
- Networks
- GIS

Each of these methods, their advantages and disadvantages are discussed below:

### 3.1.1 Checklists

Checklist gives a list of indicators that may be affected by a project being sited in a particular environment. They may include; physical, biological, social and economic factors that may be affected by the project. Glasson et al (1999) classified checklist as; Simple check list, Descriptive check list or Threshold of concern checklist

A typical checklist for water supply and sanitation project is presented in Table 3.

### 3.1.2 Matrices

The matrix most commonly used for impact identification is the Leopold Matrix developed by Dr. Luna Leopold (See Leopold et al, 1971). It is based on hundred (100) specified actions in the horizontal axis and eighty-eight (88) environmental items in the vertical axis. In using this matrix, each action and its potential for causing an impact on the environmental item is considered. If an impact is anticipated, a diagonal line is used to represent the point of interaction between an action and an environmental item. The Leopold Matrix can then be used to determine the interaction in terms of magnitude and importance.

A typical section of the Leopold Matrix with list of its elements for a water supply and sanitation project is presented in Table 4.

**Table 3 : Checklist for rural and urban water supply and sanitation projects**

**Aspects of EIA** **Checklist Questions** 1 2 3

Will the project

**Source of Impacts**

1. Require the acquisition or conversion of significant areas of land for reservoir works etc (e.g. > 50 ha rural, > 5 ha urban)? ☐ ☐ ☐

2. Result in significant quantities of eroded material, effluent or solid wastes? ☐ ☐ ☐

3. Require significant accommodation or service amenities to support the workforce during construction (e.g.> 100 manual workers)? ☐ ☐ ☐

**Receptors of Impacts**

4. Flood or otherwise affect areas which affect support conservation worthy terrestrial or aquatic ecosystems, flora or fauna (eg protected areas, wilderness areas, forest reserves, critical habitats, endangered species); or that contain sites of historical or cultural importance? ☐ ☐ ☐

5. Flood or otherwise affect areas which will affect the Livelihoods of local people (e.g. require population resettlement; affect Local industry, agriculture, livestock or fish stocks; reduce the availability of natural resource goods and services)? ☐ ☐ ☐

6. Involve sitting sanitation treatment facilities close to human settlements (particularly where locations are susceptible to flooding) ? ☐ ☐ ☐

7. Affect sources of water extraction? ☐ ☐ ☐

**Environmental Impacts**

8. Cause a noticeable permanent or seasonal reduction in the volume of ground or surface water supply? ☐ ☐ ☐

9. Present a significant pollution risk through liquid or solid wastes to humans, sources of water extraction, conservation worthy aquatic ecosystems and species, or commercial fish stocks? ☐ ☐ ☐

10. Change the local hydrology of surface water-bodies (eg streams, rivers, lakes) such that conservation-worthy or commercial fish stocks? ☐ ☐ ☐

11. Increase the risk of disease in areas of high population density (eg onchocerciasis, filariasis, malaria, hepatitis, gastrointestinal disease)? ☐ ☐ ☐

12. Induce secondary development, eg along access roads, or in the form of entrepreneurial services for construction and operational activities? ☐ ☐ ☐

**Mitigation Measures**

13. Be likely to require mitigation measures that may result in the project being financially or socially unacceptable? ☐ ☐ ☐

Comments

I recommend that the programme be assigned to category ☐ ☐ ☐

Signature: Delegation ………………………….. Desk ……………………

*Key: 1-Yes; 2-No; 3-Additional data needs*

**(Source: UNEP, 2002)**

**Table 4 : Leopard Matrix with elements for water supply and sanitation project**

| **Environmental Effects** / **Developmentt** | | Sedimentation | Milliscreening | Oxidation ponds | Activated Sludge | Trickling filter | Nutrient removal | Chlorination | Further treatment offsite | Disposal - Land | Rapid infiltration | Surface flooding | Spray irrigation | Disposal – Inland Water | River | Lake | Disposal – Marine Water | Estuary | Inshore marine | Offshore marine | Deep well injection | Treatment | Communication |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **BIOLOGICAL ENVIRONMENT** | Forest | | | | | | | | | | | | | | | | | | | | | | |
| | Shrubland | | | | | | | | | | | | | | | | | | | | | | |
| | Grassland | | | | | | | | | | | | | | | | | | | | | | |
| | Herbfield (alpine) | | | | | | | | | | | | | | | | | | | | | | |
| | Sand/shingl e/rock | | | | | | | | | | | | | | | | | | | | | | |
| | Cropland | | | | | | | | | | | | | | | | | | | | | | |
| | Urban land | | | | | | | | | | | | | | | | | | | | | | |
| | Lakes | | | | | | | | | | | | | | | | | | | | | | |
| | Rivers | | | | | | | | | | | | | | | | | | | | | | |
| | Estuaries | | | | | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inter-tidal | | | | | | | | | | | | | | | | | | | | | | |
| | Marine | | | | | | | | | | | | | | | | | | | | | | |
| | Wetlands | | | | | | | | | | | | | | | | | | | | | | |
| **PHYSICAL ENVIRONMENT** | River regime | | | | | | | | | | | | | | | | | | | | | | |
| | Erosion/land stability | | | | | | | | | | | | | | | | | | | | | | |
| | Sedimentation | | | | | | | | | | | | | | | | | | | | | | |
| | Surface water | | | | | | | | | | | | | | | | | | | | | | |
| | Ground water | | | | | | | | | | | | | | | | | | | | | | |
| | Agricultural soil | | | | | | | | | | | | | | | | | | | | | | |
| | Foundation materials | | | | | | | | | | | | | | | | | | | | | | |
| | Climate/atmosphere | | | | | | | | | | | | | | | | | | | | | | |
| | Nuisance (noise, dust, smell) | | | | | | | | | | | | | | | | | | | | | | |
| | Landform | | | | | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOCIAL ENVIRONMENT | Public participation | | | | | | | | | | | | | | | | | | | | | | |
| | Employment | | | | | | | | | | | | | | | | | | | | | | |
| | Settlement | | | | | | | | | | | | | | | | | | | | | | |
| | Land value | | | | | | | | | | | | | | | | | | | | | | |
| | Existing land uses | | | | | | | | | | | | | | | | | | | | | | |
| | Risk and anxieties | | | | | | | | | | | | | | | | | | | | | | |
| | Personal and social value | | | | | | | | | | | | | | | | | | | | | | |
| | Historical/cultural | | | | | | | | | | | | | | | | | | | | | | |
| | Landscape/visual | | | | | | | | | | | | | | | | | | | | | | |
| | Recreation | | | | | | | | | | | | | | | | | | | | | | |

**(Source: UNEP, 2002)**

### 3.1.3 Networks

This method developed by Sorensen (1971) is useful in identifying various interrelationships between the cause factor of an operation and the impacted environmental items for these operations. The method is very useful in identifying secondary, and other higher order impacts. It is also very useful for determining direct and indirect impacts.

The method is based on identifying potential causes of environmental changes that occur with a proposed development action using matrix format. The environmental changes then result in some form of environmental impacts; this impact is further traced until a final impact is identified in the chain.

Table 5 shows an example of a network diagram for a proposed plan to increase the use of groundwater for irrigation by providing subsidies for sinking deep tube wells. The main crop in the area is rice. Detailed prediction work following scoping would estimate the level to which the groundwater would fall and quantify the impacts which, together with economic analysis, would clarify which impacts were most important, the most likely and also determine the most suitable mitigation measures.

**Table 5 : Example of network analysis showing the impact of a policy to utilize groundwater by subsidizing tubewells**

| **Primary impacts** | **Secondary impacts** | **Tertiary impacts** | **Quaternary impacts** | **Mitigation** |
|---|---|---|---|---|
| **Lowering of groundwater in dry season** | Loss of income & water from domestic hand pumps | Use of poorer quality water | Increased health risks | 1. Ensure that the new DTW either hold domestic water locally or feed into distributary system<br>Note Effected group are poorer people |
| | | Income diverted to buy water | Decreased income & time | |
| | | Travel to distant source | Reduced quality of life | |
| | Loss of income & water from shallow tubewells for irrigation | Income diverted to buy water | Decreased income & time leading to possible food shortage | 1. Deepen STW |
| | | Crop failure | Reduced quality of life | 2. Ensure new DTWs supply STWs in dry season |
| | | | Abandonment of | 3.Provide compensation from |

| | | | | |
|---|---|---|---|---|
| | | | land & migration | DTW taxation |
| | Drawdown of surface water bodies | Decreased fish capture/fish mortality | Loss of protein intake | 1. Artificially stock water bodies |
| | | | Loss of income for fishermen | 2. Recharge water bodies from DTW Note: Fishermen are already poorer than farmers in general |
| | | Loss of wetland | Loss of wetland flora/fauna migratory birds, fish spawning areas | |
| | | | Loss of wetland products | 1. Restrict DTW development in vulnerable areas Note Landless & Rural poor are greatest users of wetlands |
| | | Reduced navigation possibilities | Increased transport costs | 1. Increase navigation depth by dredging |
| **Agricultural intensification** | Increased fertilizer | Groundwater contamination by nitrate | Polluted drinking water by nitrate causes various illness, particularly in babies | 1. Control fertilizer use 2. Educate users of groundwater as well as fertilizer users babies |
| | | Eutrophication of surface water due to runoff | Increased weeds in channels & surface water bodies, algal blooms | 1. Remove and control weeds |
| | | | | 2. Educate about dangers of algal blooms |
| | Increased pesticide use | Groundwater contamination | More expensive alternative for drinking water must be found | 1. Regulate pesticide use |
| | | Poisoning of fish & shrimp | Reduction in fish catches & protein availability | 2. Encourage rainwater storage |
| | | | Reduced income for fishermen | 3 Encourage integrated pest management |

| | | | | |
|---|---|---|---|---|
| | | | Bioaccumulation of pesticide in man | 4 Subsidize non-persistent pesticides |
| | | | | 5. Tax undesirable pesticides |
| | | | | 6. Educate pesticide users & fish eaters |
| | Increased level of pest & diseases vectors due to loss of fallow period | Increased pesticide use | Bioaccumulation of pesticide in man | 1. Vaccinate to prevent epidemics |
| | | Increase in animal & human disease due to vector | Loss of quality of life | 2. Encourage alternative cropping patterns |
| | | | | 3. Educate about disease vectors |
| | Reduced fallow land & grassland for grazing | Fewer livestock or poor quality livestock | Reduced protein intake & income for landless groups | 1. Develop alternative grazing |
| | Reduced scrubland for fuel wood | Alternative sources sought for fuel | Income & time spent collecting fuel | 1. Develop fuel wood supplies |
| | | | Destruction of trees | 2. Introduce more efficient cookers |

*STW=shallow tube wells*
*DTW = deep tube wells*

**(Source: Dougherty et al., 1995)**

### 3.1.4 Use of GIS

GIS is a computer system for capturing, storing, querying, analysing and displaying geospatial data (Chang, 2010).

GIS technology is based on organising information into a series of layers which can be integrated using geographic location or coordinates (Arctur and Zeiler, 2004).

In using GIS for impact assessment, each GIS database is organised into a series of thematic layers to represent and answer questions about a particular problem such as land use, vegetation cover, hydrology, topography, and soil type. In each cell of a particular layer, there is only a single value or thematic attribute.

The applications of GIS in EIA are numerous. GIS can be used in impact identification as well as analysis of potential impact. This is done using overlay principles i.e. by overlay of soil type, topography, vegetation, ground water, surface water geology and other parameters, potential impacts can be identified.

Many models have been coupled with GIS to simulate processes such as soil erosion, groundwater movement and runoff, thus enabling the estimation of their impacts on development project. Additionally, GIS can be used in impact mitigation planning.

## 3.2 Impact Prediction

The existing state of the environment must be carefully evaluated and described in order to identify the types and amount of impact the proposed development project will cause.

Impact prediction is undertaken in order to determine the magnitude and significance of the identified changes in the environment when a project/program is proposed. This includes determining whether an impact is direct or indirect, beneficial or adverse, the scope of an impact, and the duration in which the impact is expected to occur ( short or long term).

The most common method of evaluating impact is by referring to the predicted impact with legislative requirements and standards, e.g. water quality and air quality standards.

### 3.2.1 Impact Prediction Models

Prediction of impact involves the projection of baseline environmental settings with or without the project and then using some empirical models to predict the impact of the proposed development. Impact prediction may be accomplished by using mathematical models to predict spatial distribution of impacts or location-based impacts. They may be deterministic or stochastic.

While deterministic models are based on fixed interrelationships, stochastic models are used to determine the probability that a certain number of events are likely to occur in a given area and at a specific time interval.

Statistical models have been found to be very useful in pollution monitoring to describe the concentration of a pollutant as a function of stream flow (Classon et al 1999) and in flood frequency analysis.

Impact prediction can be made intuitively by comparing the impacts of a proposed development project with a similar type of project carried out elsewhere or by comparing environmental conditions on one site with those of a similar site in another location.

In a proposed water supply and sanitation project, typical EIA prediction will include the following:

- Prediction of sediment transport into a river as a result of the project.
- Estimation of water loss from water seepage.
- Investigation of the stability of geological structure of the earth mass below the project area.
- Estimation of the number of personnel to be displaced as a result of the project.
- Investigation of Flora and Fauna in the project area.
- In the downstream area, estimation of changes in water quality parameters, estimation of areas likely to be affected by bank erosion, and estimation of fish species that will be affected by change in water quantity and quality.
- Identification of diseases prevalent in the area and prediction of changes in disease occurrence.
- Determining susceptibility of the project site to water logging.

## 3.3 Impact Evaluation

On completion of impact prediction and analysis, it is necessary to evaluate the impacts 'relative' significance. The parameters for measuring the significance of the impact will normally include the magnitude of the impact, spatial coverage, the possibility of quick recovery from the impact by the environment, the level of concern of the citizens and the socio-economic and political implications of the impact.

In most societies the most common evaluation for significance is to compare the likely impact against legislative, national and international standards.

Another known analytical method of significance of impact includes cost-benefit analysis and monetary valuation techniques

In water supply and sanitation projects, the cost benefit analysis should reflect three key factors which should include:

1) **Economic costs and benefits.**

The most noticeable economic costs include: land acquisition for reservoir and other works, machinery and equipment for construction and rehabilitation works. The benefits may include increase in infrastructural development within the environment and generation of employment for nearest settlements

2) **Social costs.**

The costs include disruption of social fabric, unemployment of displaced persons, increase in crime rate as a result of the influx of people, increase in cost of essential commodities, exploitation of rural dwellers and higher incidence of water borne diseases.

3) **Environmental costs.**

The environmental costs include loss of forest land, wildlife and endangered species, water and air pollution with attendant water borne and respiratory diseases, loss of agricultural land as a result of erosion

### 3.3.1 Environmental Evaluation Issues for Water Resources Project

The environmental impact assessment of a water resource and sanitation project usually covers a large spatial area. The major impacts from dams and reservoir development include: water development and stream flow management, flood control, water supply, power and other services within the project area.

Since a number of environmental impacts are more likely to be adverse it is also important to evaluate the potential impacts of alternative designs.

The environmental impacts that may occur during the construction of dams and reservoirs may be classified and summarized as follows:

1. **Land converted to reservoir use**

The impact may include:

- Loss of fish and other aquatic or marine habitat.
- Loss of access to mineral deposit.
- Loss of wild life and other endangered species.
- Inundation of historical, religious or traditional site.
- Inundation.

2. **Alteration of stream flows**

The impact may include:

- Reduction of fish and aquatic habitat.

- Changes in water quality.
- Loss of access to recreational facility.
- Loss of scenic sites
- Reduction of stream flushing flow.

**3. Interference with fish and wild life migration**

- Blocking of animal migration routes
- Blocking of anadromous fish runs

**4. Change in Landscape appearance**

- Unsightly waste and dumping sites.
- Littering around construction facilities and equipment.
- Waste disposal from reservoir clearing.
- Change in vegetation cover due to reduction in down stream flows
- Gully and erosion from construction access roads and paths.

# 4.0 IMPACT MITIGATION AND MANAGEMENT

## 4.1 Impact Mitigation

Impact mitigation is carried out after identifying and predicting impacts. The purpose of impact mitigation is to search for alternatives and better ways of implementation of projects so that negative impacts are eliminated or at least minimized. Impact mitigation can only be carried out after evaluation. If an evaluation indicates that an impact is significant then one of the following measures may be taken:

1. Avoid the impact: This may mean not undertaking the project or parts of the project that may result in adverse impact. Additionally, areas that are environmentally sensitive may be protected from activity and harmful impacts.
2. Minimization of impact: This can be done in order to reduce the extent, magnitude or duration of an adverse impact. This may result in scaling down, relocating the project or redesigning some components of the project to manage the impacts. This can include rehabilitation, restoration and replacement of critical elements of the affected site.
3. Compensate for impact on affected or displaced persons: Rehabilitation is considered in most developing countries as a costly obstacle to project implementation, and authorities to provide compensation. Provision of measures such as land and basic amenities should include water and sanitation facilities, education and health facilities.
4. Reduce or eliminate impact overtime: This can be done by maintaining a minimizing strategy during the life time of the action.

Some impacts in connection to water and sanitation projects and method of mitigation are presented in Table 6 below;

**Table 6: Summary of Avoidable and Unavoidable Adverse Effects of Dams and Reservoirs on Environment**

| Reference No. | Potential adverse effect | Mitigation method or effect | Probable degree or importance of adverse effect |
|---|---|---|---|
| A. | Land use for reservoir | | |
| A. 1. | Loss of fish and aquatic habitat | Changes of species | New species may be less desirable than original species |
| A. 2. | Loss of wildlife habitat | Improve other areas for habitat | Full mitigation probably not possible |

| | | | |
|---|---|---|---|
| A. 3. | Loss of future access to mineral deposits | None | Is of importance only if mineral deposits exist |
| A. 4. | Loss of mountain valley areas | None | Important only in extremely mountainous areas |
| A. 5. | Inundation of historical or archaeological sites | Possibly by a museum | Varies with each individual site |
| A. 6. | Inundation of exceptional geological formations | Usually not possible | Varies with each individual site |
| B. | Alterations of downstream flow | | |
| B. 1. | Reduction of fish and aquatic habitat | Maintain regulated flows | Full mitigation possible, but frequently not acceptable because of large sacrifice of project accomplishments |
| B. 2. | Reduction of stream flushing flows | Release occasional flushing flows | Mitigation method not proven to be worthwhile. Degree of environmental effect demands upon specific stream situation |
| B. 3. | Changes of water quality | Selective level reservoir outlets; water aeration if needed | Somewhat limited experience with selective level outlets indicates good prospects of full mitigation |
| C. | Interference with fish and wildlife migrations | | |
| C. 1. | Blocking anadromous fish runs | Fish hatcheries | Usually capable of full mitigation |
| C. 2. | Blocking animal migration routes | None practical | Importance depends upon the specific site |

| | | | |
|---|---|---|---|
| D. | Landscape appearance | | |
| D. 1. | Excavation and waste disposal sites | Project expenditures required to landscape sites | Satisfactory mitigation usually possible without excessive expenditure |
| D. 2. | Reservoir banks below maximum waterline | Minor areas may be developed for beaches | Degree of impact depends upon the specific reservoir site |
| D. 3. | Abandoned construction facilities | Construction clean-up | Full mitigation possible. Important only if not done |
| D. 4. | Erosion scars from construction roads | Principally by care of drainage | Adverse effects can be reduced but not entirely eliminated within reasonable cost |
| D. 5. | Reservoir clearing waste disposal | Controlled burning. Marketing maximum amounts of wood products | Temporary effect; usually minor, but entirely avoidable |

**(Source: Golze, 1977)**

## 4.2 Environmental Management Plan

An environmental management plan is a document that details all activities to be implemented by the client and stakeholders to minimize the adverse impact of a project development throughout its life cycle.

The environmental management plan is designed to ensure that mitigation measures and recommendations given in the EIA are implemented. The environmental management plan should include a table showing the project activities, description of the potential impacts, mitigation and their costs, in line with a Polluter-Pays principle, responsibility for carrying out the listed activity, their frequency as well as verifiable indication, monitoring and auditing reports.

Typical table of EMP matrix is presented in Table 7 below.

**Table 7 : Sample format for EMP Matrix**

| Project Activities | Potential Impact | Mitigation / Enhancement Measures | Cost of Mitigation and \ Enhancement | Responsible Authority | Frequency of Monitoring | Verifiable Achievement |
|---|---|---|---|---|---|---|
| **1. Planning/Design Phase/Construction phase** | | | | | | |
| Clearing of project site<br>Excavation of site<br>Laying of pipes | | | | | | |
| **2. Operation and Maintenance phase** | | | | | | |
| Water abstraction<br>Discharge of effluent | | | | | | |
| **3. Decommissioning and closure** | | | | | | |
| Removing the infrastructure<br>Restoring the site | | | | | | |

## 4.3 Reporting in EIA Process

The EIA report which is known as the Environment Impact Statement (EIS) should contain an overview of the project, characteristics of the project area or site description, potential impacts (beneficial or adverse) on the environment, identification and quantification on type of impact, proposed mitigation process and costs, and procedures for post construction monitoring and evaluation.

The format for the EIA report presentation should include, but not be limited to, the following:

- Executive summary of the report
- Background to the study: This should include the justification for the project, objectives, project location, alternatives, legal and administrative framework.
- Approach and methodology: This should address issues such as general approach to problem solving, geographic location of project, environmental quality indicators and assumptions made in designing the project.
- Environmental baseline studies.
- Impact identification, prediction and evaluation.
- Impact mitigation.
- Environmental management plan
- Conclusion and recommendations.
- References and appendices.

## 4.4 Public Participation in EIA Decision Making

The United Nation Environmental Programme (UNEP) lists five interrelated components of effective public participation (Glasson et al 1999). These include:

- Identification of the group/individuals interested in or affected by the proposed development.
- Provision of accurate, clear, reliable and timely information.
- Effective discourse between those responsible for the decisions and those affected by them.
- Evaluation of public attitude to the project.
- Feedback about the final action taken and the influence or role of the public participants in decisions

In Nigeria, participation is usually in form of a public hearing where stakeholders are invited to a presentation of the EIA report or EIS. Notice is given to the stakeholders at least 2 weeks before the meeting through a media selection of newspapers, radio and television announcements, and oral communication to community leaders. Social centres/halls and hotel conference rooms are usually selected as venues for the public hearing.

An approval for project development is then sought by project applicants through the Federal Ministry of Environment, who then grant permission for project development once there is a satisfactory design including appropriate mitigation measures.

## 4.5 Monitoring

Monitoring in EIA refers to a systematic collection of information about the physical, social and economic parameters associated with development impacts.

Monitoring can be used as an early warning system to identify potentially dangerous and harmful impacts before they occur.

In water resources and sanitation projects, the key areas to be monitored should include effective implementation of mitigation measures, changes in water flow and levels, solid waste discharge, water quality (e.g. for pH, dissolved oxygen, heavy metals, total coliform, etc.) and public health monitoring of local populations.

In general, the objectives of the environmental monitoring should include, but not be limited to, the following:

- Ensure early detection of unexpected impacts and then to design mitigation measures as appropriate
- Carry out measurement of the scope, changes and severity of impacts
- Determine whether or not measures adopted for an impact are successful

- Provide indication how monitoring data will be utilized technically and systematically to improve mitigation measures
- Identify the training and other capacity building requirements for the project necessary for implementing mitigating measures

There are four types of monitoring that may be implemented in EIA (Achieng Ogola, 2007). They include:

**Baseline Monitoring:** This involves carrying out basic measurement of environmental parameters within and around the project area using transects. Subsequent measurement of the same parameters during and after the construction can then be used to determine what changes have taken place as a result of the project.

**Impact Monitoring:** This is the monitoring of biophysical and socio-economic parameters within the project area during the development and operational phase of the project to determine the changes that have taken place overtime.

**Compliance Monitoring:** This is used to ensure that environmental quality indicators such as water quality, air quality and other environmental parameters comply with required environmental protection standards.

## 4.6 Trans-boundary EIA

Once it is discovered that impact ensuing from development of a water resource and sanitation project will be trans-boundary, it becomes necessary to notify the neighbouring states of an intention to conduct EIA.

After consultations, a project brief is prepared. This is followed by screening and scoping within the EIA process.

A base line design is selected for the acquisition of the base line date. All the neighboring states are informed about the baseline study and, on completion of acquisition of base line data, and an environmental impact statement is prepared.

Public hearings are launched in which the affected trans-boundary states are expected to participate.

## 5.0 CASE STUDY IN EIA PROCESS

The general summary of baseline data acquisition for an EIA Process is as follows:

- Develop checklist in accordance with type of project.
- Develop field sampling methodology
- Prepare list of equipment and personnel required for the sampling.
- Develop questionnaire for distribution to the stakeholders
- Identify stakeholders
- Carryout field sampling
- Administer questionnaire
- Carry out laboratory tests.
- Carry out analysis of laboratory results, prepare plans and drawings.
- Identify most feasible method of impact analysis.
- Carry out impact analysis.
- Draw conclusion and develop line of action.

### 5.1 Description of the case study Area

The project area for the Dam and Reservoir is between Latitude $09^0 38'$N to $09^0 48'$N and Longitude $07^0 42'$E to $07^0 49'$E and covers an area of approximately 150km$^2$. The pipeline route covering a 60m wide Right of Way (ROW) extends for a distance of 75km from upper Gurara Reservoir in Kaduna State to the existing lower Usumen lake in the Federal Capital Territory, Abuja (see Fig 7). The topography of the Gurere basin consists of undulating plains with sporadic rocky hills and dissecting plains. The climate in this area is the tropical continental climate characterized by wet summer and dry winter. Mean annual temperature in the study area is about 27$^0$C. Mean monthly temperature vary from 25$^0$C in July to a maximum of 35$^0$C in February/March. The mean relative humidity vary from 50% to 60%. This has far reaching impact on evaporation and evapotranspiration from large water bodies and surrounding vegetation.

The geology of the area is of the basement complex. The basement complex underlies the whole of Kaduna Plains. The basement rocks are extensively deformed by the Pan African Orogeny. Three main fracture trends are visible from satellite imagery. These include the N-S, NW-SE and the NE-SW linements. The most pronounced linement is the N-S trends and this conforms with the trend of the foliations of the bedrock gneiss. The flow of the Gurere River in the region is essentially N-S and appears to be controlled by this fracture trend (WADSCO, 2004). Downstream, the river flows generally in a S-W direction and this is controlled by the NE-SW and locally by NW-SE fracture.

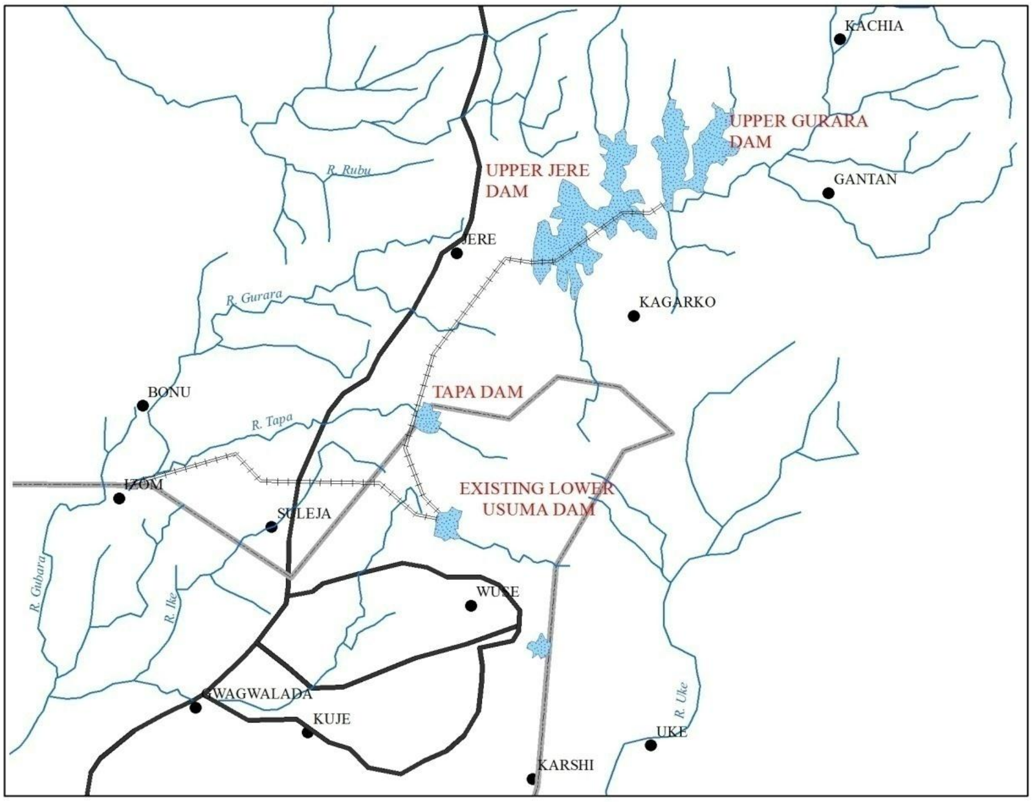


**Figure 5: Layout Plan of Project Area**

## 5.2 Baseline Data Collection

Data was collected during two seasons; the wet and the dry. Based on the project type, the following environmental issues were deemed to constitute the scope of the Impact Assessment.

1. Air Pollution
2. Soil Studies
3. Land Use Studies
4. Demography Studies
5. Meteorology
6. Geology of the Project Area
7. Geomorphology of the Project Area
8. Vegetation
9. Ecology-Forestry, Terrestrial
10. Fauna and Wildlife, Water Ecology
11. Surface Water Studies
12. Ground Water Studies (Hydrogeology and Ground water quality)
13. Social Economic Studies
14. Health Impact Studies

## 5.3 Baseline Data Acquisition

### 5.3.1 Air Pollution Assessment

Baseline studies were conducted to determine the background elements in the project area. Information on existing air quality in the project area with regards to air pollutants that are emitted from existing activities were collected, including the types pollutants associated with the upper Gurara Dam/Reservoir and the conveyance pipeline to lower Usuma.

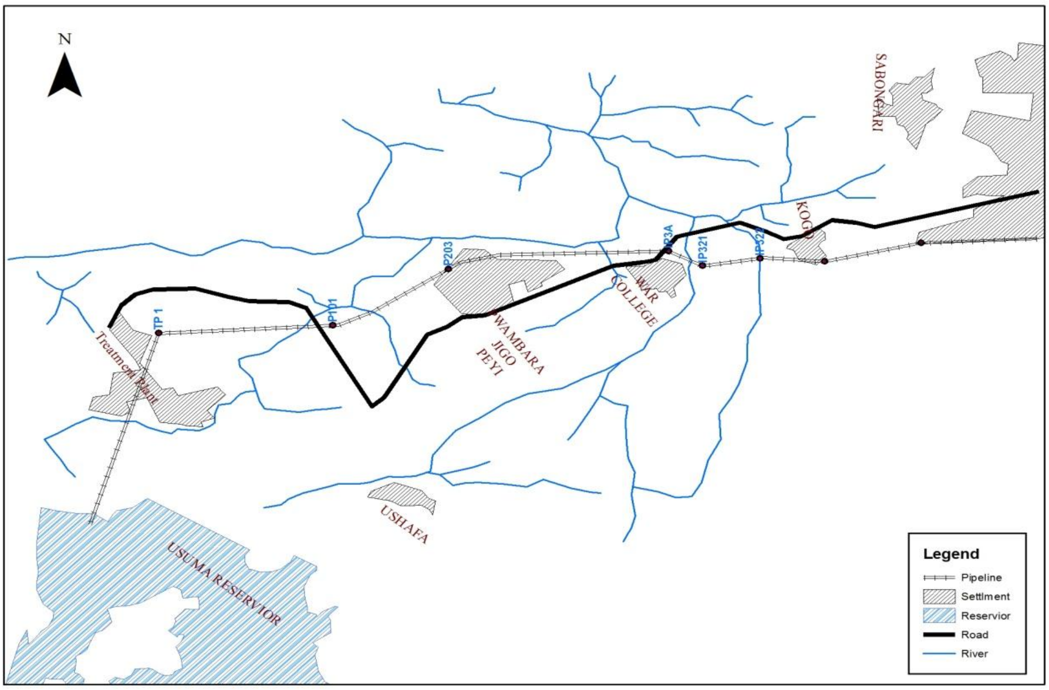


**Figure 6: Location of Dams and Water Pipeline Route**

Construction of reservoirs was reviewed. The present activities within the above areas do not involve much pollution since gaseous emissions are absent. However, during construction it was envisaged that excavation of soils on the rugged terrain and blasting of rocks will generate dust. Additionally, spray mist will be generated during the reservoir filling and emptying operations.

#### 5.3.1.1 Assessment of Potential Impacts of Gaseous and Particulate Emission

The studies show that the level and effects of gaseous emission from the proposed project activities are almost zero. The level and effects of particulates were found to be very small, aside from drilling the construction plan. As the water was of high quality from laboratory tests and analysis, it was concluded by the study group that the spray and mist that may be generated during reservoir filling and discharge operations will be similarly devoid of airborne pathogenic organism.

### 5.3.2 Soil and Water Studies

The soil sampling sites were selected to adequately represent the various land system of the existing scheme. The data used in the survey were mainly from primary and secondary source, with primary soil data collected from field surveys. Secondary data was obtained from published works, maps, and journal articles.

Samples collected from profile pits were analyzed for particle size distribution, soil, pH, total Nitrogen, organic carbon, available exchange bases (Ca, Mg, Na,and K) cation exchange capacity (CEC), base saturation, exchange acidity, and effective cation exchange capacity (ECEC)

Water samples were collected by the study team from lower Usuma Dam, and upper Gurara River. Ground water samples were collected from lower Usuma Dam. The water samples were taken to the laboratory for tests and analysis to determine the extent of water pollution load in terms of sodium Absorption Ratio, Electrical conductivity, Acidity, Nitrates, Sulphates, Boron, Chlorides, Zinc and Heavy metals.

The results of the tests indicate that silt content in the soil is moderately low. Mean value of fine sand content at the top soil are higher than those values at sub surface soils. At the top soils, the values of fine sand content ranged from 30% to 69% with a mean of 47.6% Coarse sand content are higher at the sub surface than at the surface. Analysis by textural classes showed that the predominant textures are sandy loam or sandy clay loam in all locations. Textural classes of the soils during the rainy season did not differ from those of the dry season. The parent materials which consist significantly of gneiss and older granite have significant influence on the texture of the soils formed from them.

From the pH values obtained, the soils are moderately acidic. The results of the tests for organic content did show that the soil generally contain high levels of organic matter than the sub surface soils values of Nitrates following a similar pattern. Generally, in most of the location and based on the soil chemistry, the percentage quality of soil nutrients lost between the rainy and dry seasons have a negative impact on crop production and soil ecology.

### 5.3.3 Land Use Pattern

In this area, farming is the main occupation of the people. Cultivation is concentrated around settlements. The uncultivated areas are made up of fallow plots of areas of undulating surfaces, severely eroded with steep slopes or open bush land far from settlements. Most of the cultivated areas are used for grazing.

One of the most prominent features of the landscape in the Guara Basin is the settlement pattern. Villages of different sizes occur throughout the area. Some of these are rural towns which serve as local Government headquarters while others are tiny settlements of between 3 – 10 houses in cluster crop cultivated and livestock rearing is the main form of economic activity of the people. At upper Gurara and lower Usuma Dam areas forest reserves are still in existence even though incursion by the local people is reducing the extent of the forest lands.

Residential land use consists of rural residential areas, urban lands and commercial lands, badlands and erosion sites occur in parts of the Gurara basin. In these areas deep ravines appear on the landscape. The slope for most of the land is steep and rapid runoff is prevalent, causing erosion. Consequently debris and soil particles are carried into streams and rivers, thus increasing the sediment deposit in rivers. Along the pipeline route, rural settlement are prevalent except within the Federal capital territory area where urban land use for residential, commercial, government/Civil public and amusement parks are being established.

#### 5.3.3.1 Land Use Constraints in the Project Area

Due to difficult terrain, land use will not progress in all directions with equal intensity. In some parts such as upper Gurara and Bwari, land use is constrained by rocky terrain that does not favour agriculture. In addition, soil erosion is creating problem for expanding agricultural practices in areas such as upper Gurara and Tapa districts.

### 5.3.4 Vegetation

Natural vegetation in the Upper Gurara River and lower Usuma Dam is mixed with LEGUMINOUS WOODED Savanna which consist of tall grasses with scattered trees, the dominant tree being AFRICALIA AFRICANA. Patches of forest dot the upper slopes. Secondary forest covers most of the river tributaries. Some changes to the botanical composition of the vegetation are taking place and this is ascribed to changing climatic influences. In this area, there are remnants of undisturbed forests maintained as forest reserve.

Forest clearing along with continuous cultivation is giving rise to original forest cover changing to scrub land or savanna type vegetation. Flood plains, referred to in Hausa language as (FADAMA), occur in the study area around and along the banks of Gurara and Tapa rivers.

Flood plains are not very extensive but they constitute an important source of dry season grazing resources. In the flood plain or FADAMA and river banks, characteristic grassy vegetation composed of various species may occur. There is however little change in species from one vegetation zone to another. The actual site composition is affected by small difference in relief and in the persistence of the high water table or by inundation

### 5.3.5 Forestry and Wild Life in the Project Area

The study area lies within the most extensive ecological unit of the Guinea savanna. There is an abundance of economic tree species found in the area. According to the interview conducted by the researchers wild life is limited in the area but herbivorous animals that feed on grasses (usually livestock) are numerous.

### 5.3.6 Water Ecology

Baseline data for water ecology covers zooplankton, phytoplankton and fish species. The three groups of zooplankton identified in the area included CLADO CERANS, COPEPODS & ROTIFERS. CLADOCERANS have the highest occurrence, particularly in Usuma lake. COPEPODS and ROTIFERS were more prevalent in the fast flowing stream environments.

In the study area, only a few fish species were recorded. In the study area fishing is usually done during the onset of the dry season, i.e. September to October. In economic terms, the fish catch is highly prized in this area as it acts as a source of domestic income to most local inhabitants.

### 5.3.7 Impact of Water Weed

Aquatic weed grows both in the upstream and downstream section of the Dam. The aquatic weeds were observed by the study group to be currently insignificant in population and therefore their total impact on evapotranspiration is minimal.

The ecological factors which favour their growth includes semiarid and prolonged dry season, strong in-coming wind from the south, increased nutrient level of rivers, lakes, streams, flooding of habitants and sheet wash erosion into the rivers and streams during the raining season.

### 5.3.8 Surface Water Studies

Surface water (rivers and streams) that may be affected by the dam and pipeline route are the Gurara, Usuma, Inyi, Jubi, Tapa and Aku, and Nako and Ela streams. The flow rates, channel width and water uses of these rivers and streams are presented in Table 8. On each river/stream, at least four measurements were taken at random distances from each other.

**Table 8: Average Record of Rivers/Streams Physical Characteristics and Their Uses**

| S/No | Rivers/streams | Mean flow rates (m/s) | Mean water width (m) | Mean water depth (m) | Water uses |
|---|---|---|---|---|---|
| 1 | Gurara | 4.5 | 25 | 4 | B, C, D, W, F, Fs |
| 2 | Usuma | 1.2 | 10 | 3 | B,W,F,Fs |
| 3 | Inyi | 0.8 | 8 | 1.5 | B,C,D,W |
| 4 | Jubi | 1.0 | 5 | 1.3 | B,C,D,W |
| 5 | Tapa | 1.1 | 12 | 4.8 | B,W,F,Fs |
| 6 | Iku | 0.6 | 7 | 1.2 | B,C,D,W |
| 7 | Nako | 0.5 | 5 | 0.8 | B,C,D,W |
| 8 | Ela | 0.8 | 6 | 1.1 | B,C,D,W |

**(Source: WADSCO, 2004)**

*Reference Codes: B-Bathing; C-Cooking; D-Drinking; W-Washing; F-Farming; Fs-Fishing

It is clear that the rivers and streams perform useful functions to the inhabitants of the project area and flow rates and water depths are generally about 1.0m/s and 2m respectively.

The rivers/streams generally reflect spatial variation of surface current on account of the magnitude of the stream order and the stage of the river/stream. First order stream are youthful and show swift surface current flow: the second order streams show large surface current which is not very fast because of the matured stage of the rivers.

River Gurara, which is a $4^{th}$ order river, has the largest surface water discharge, because of its many tributaries and the size of the current increases downstream. However the velocity of flow is remarkably fast because of the rugged topography it traverses.

All the rivers/streams reflect marked temporal variation of surface currents in consonance with the seasonality of rainfall in the area. Surface current increases during the rainy season between the months of May and September and drops significantly from October through to April during which period, river/stream flow is barely maintained by groundwater (base flow).

The physio-chemical characteristics of the rivers/streams show that pH, turbidity and sediment load are high. Most rivers/streams are acidic with pH level of 5.8 to 6.9 for Usuma stream, Ela, Nako, Gurara and Tapa rivers. Others show a general tendency towards basic and neutral pH values.

All the rivers/streams are muddy in colour which is indicative of the erosional activities of these youthful rivers/streams. Hence high turbidity and sediment load is common among these rivers/streams.

The rivers/streams are open to pollution agents from agricultural farmlands heavily laden with fertilizer and human faeces as the people freely defecate in the bush.

**5.3.8.1 Surface Water Analysis**

Mid-stream water samples were collected within the project area- Upper Gurara River, Lower Usuma and stream around the Usuma Dam. The purpose of collecting water samples was to determine the extent of water pollution and investigate the impact of land use on the water quality of the rivers for human consumption. Analyses included examination of water and waste water on the soil, water and plant analytical services outfit, near Green House Gate, University of Nigeria, Nsukka. The analyses were conducted to determine the water acidity (ie. pH), Electrical Conductivity and concentrations of Nitrates, Sulphates, Boron, Chlorides, Zinc, Copper, Iron, Lead and Chromium. The results of the analysis are presented in Table 9

Results show that water samples from upstream of Lower Usuma Dam and downstream of Lower Usuma Dam have pH value of 6.1 and 6.9 respectively. These values are slightly acidic but the value of the surface stream water is more acidic than others as shown in Table 7.

Upper Gurara River with pH of 7.3 is near neutral. In terms of Boron and Copper contents, the three water samples contain equal amounts of these elements. Iron content (Fe) is quite high for surface stream water, Upstream of Lower Usuma (11.62mg/L) and very low (3.10mg/L) for water downstream of the Lower Usuma. That of upper Gurara river is moderate (6.12mg/L). Equal contents of Zinc (0.069mg/L) area recorded at Upper Gurara River and Lower Usuma Dam.

The result also shows that the highest amount of Lead (Pb) (0.72mg/L) was recorded at Lower Usuma Dam while Upper Gurara River yield half amount (0.36mg/L) of Lead of that of Lower Usuma Dam. Similarly the electrical conductivity of the water is higher (93.0ms/cm) in Lower Usuma Dam than other locations. The same trend is observed in terms of amount of Nitrate (3.73mg/L), Sulphate (658.4mg/L) and Chloride (44.0mg/L) at Lower Usuma Dam. High incidence of these heavy metals in Lower Usuma Dam could be associated with the stagnant nature of the reservoir unlike the streams and rivers that flows. This is an indication that the chemical oxygen demand could be higher in Lower Usuma Dam than for Upper Gurara River and this would encourage the chances of survival of aquatic organisms and pathogens. Also the high incidence of these heavy metals, nitrates, sulphates and chlorides is indicative of the production and transportation of sediments into the river discharges. Poor sanitary conditions and cultural land use practices may impact on the safe use of surface water.

This analysis strongly calls for water treatment before consumption, especially water from the Lower Usuma Dam and Upper Gurara River.

**Table9: Result of Water Analysis**

| Sample | Heavy Metals (mg/L) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Description | pH ($H_2$) | B | Cu | Fe | Zn | Pb | Cd | EC (ms/cm at $250^0C$) | $NO_3$ | $SO_4$ | $CL_2$ |
| Lower Usuma Stream (Upstream) | 6.1 | 10.0 | 0.022 | 11.62 | 0.052 | 0.36 | 0.010 | 70.0 | 3.10 | 411.5 | 40.0 |
| Lower Usuma Dam (downstream) | 6.9 | 10.0 | 0.022 | 3.10 | 0.069 | 0.72 | 0.018 | 93.0 | 3.72 | 658.4 | 44.0 |
| Upper Gurara River (downstream) | 7.3 | 10.0 | 0.022 | 6.12 | 0.069 | 0.36 | 0.010 | 65.0 | 3.12 | 411.5 | 38.0 |
| Mean $\bar{X}$ | 6.77 | 10.0 | 0.022 | 6.95 | 0.063 | 0.48 | 0.013 | 76 | 3.31 | 493.8 | 40.7 |
| Source (WADCO, 2004)<br>NB: B=Boron, Cu=Copper, Fe=Iron, Zn=Zinc, Pb=Lead, Cd=Cadmium, EC=Electrical Conductivity, $NO_3$=Nitrate, $SO_4$=Sulphate, $CL_2$=Chloride | | | | | | | | | | | |

**(Source:WADSCO, 2004)**

### 5.3.9 Ground Water Resources

#### 5.3.9.1 Hydrogeology

Groundwater occurrence in basement terrains is controlled by geologic features of depth of weathering (thickness and continuity of the regolith). Generally two aquifer types occur- a shallow unconfined aquifer within the regolith and a deeper one which is localized with areas of good permeability. Usually in zones of intense fracturing, regolith pores and fractures are interconnected and both vertical and horizontal groundwater movements occur. This is the situation in the project area.

Considering the nature of rock exposures - intrusive hills (with insignificant regolith) and enclosed plains often with a small valley (underlain by thick regolith cap) - it is projected that the ground water in the area occurs in small more or less disjointed basins which are protected from each other by linear stretches of very low permeability. The dimension of each basin, considering the topography of the terrain, ranges from less than 1km to over 5km across with a mean of about 2km. Groundwater flow within each basin is essentially controlled by the local relief. Within each basin recharge occurs on higher relief areas whereas discharge is confined to the valleys. The maximum distance of groundwater flow within a basin is projected to be less than 3km and the resident time (assuming a permeability value of 10-5m/s and porosity of 35%) should be in the order of a few weeks to a few months.

From field observations, the major form of groundwater discharge is through diffused seepage faces. In the rainy season, these collect to form small first order streams.

#### 5.3.9.2 Groundwater Quality

Water quality studies were done to determine if a water source is satisfactory for a proposed domestic, agricultural or commercial use. The quality of water sources in the project area was investigated based on samples collected in the field. The data was checked against historical data obtained in contiguous basins and within the basement in general. There was a good correlation between the field data and existing information and this increased the confidence placed on the results of laboratory analyses.

Electric conductivity values (a measure of the dissolved solids in water) ranged from 40u s/cm. Acidity measured as pH range from 5.8 to 6.8 suggesting that the sources are mildly acidic. The major ion concentration is far below toxic limits with most ions being less than 50. The only constitute with concentration value up to toxic limits is nitrate which ranges from 0 to 44.0 (objectionable limit=45). The high value of 44 was obtained from a hand - dug well at Bwari (the largest of the cluster of the villages within the study area). The other samples have a mean value less than 10. The antecedent rain water monitored at Abuja city has nil value of nitrate suggesting that nitrate is generally absent from the rain water. The springs and streams in the pristine terrain also had nil concentration of nitrate whereas most dug well samples registered nitrate presence.

Heavy metals analyzed include Cobalt (Co), Cadmium (Cd), Lead (pb), Zinc (Zn), Arsenium (As), and Boron (B). These are generally below the detection limits of the equipment (0.01 or 0.02). Cobalt, Cadmium and Boron showed some elevated values but these are all far below the toxic concentration limits recommended by WHO.

## 5.4 Socio Economic Studies

### 5.4.1 Demography studies

Towns and Villages within the project Area:

The project area covers part of Kachia and Kagarko Local Government Areas of Kaduna State and Bwari Area Council of FCT. The affected towns and villages in Kachia Local Government Area are found mainly within the Upper Gurara Dam Reservoir area while the pipeline passes through Kagarko Local Government Area to Bwari Area Council. The project area is completely rural in outlook and nothing associated with urban life is experienced here. Bwari town is the only urban settlement with facilities like roads, electricity, water supply, health centers, police station, market, motor Park, petrol stations and educational institutions. The Nigerian Law School and the offices of the Joint Admission and Matriculation Board (JAMB) are situated there.

### 5.4.2 Present Social-Economic Situation in the Project Area

The population of the entire project area is sparse except for Bwari town. Towns and Villages area scattered settlements of mud houses. Primary occupation of settlements is farming and the main crops cultivated include sorghum, maize, rice, yams, cassava, sweet potatoes and ginger. Most of the reservoir area is in Kachia Local Government Area of Kaduna State. The settlement of Tudun Wada, Akwana Igo I&II, Allah Mangani, Anturu, Doka, Anguwan, Kankana, Anguwan Kagarko, Atara, Asawe and Akama, all in Kachia LGA and Kadar village in Kagarko LGA are most likely to be affected by the reservoir.

No relocation is envisaged within the pipeline route. Only a few houses and farm lands would be affected by the project. A good part of the pipeline route is within the forest reserves of Giwa and Kubo. Due to poor sanitary conditions and lack of good quality water, diseases such as Bilharzia, River blindness, Filariasis, Malaria, Diarrhoea, foot rot and skin infections are present. It was observed that some of the children have ringworm and eczema. Bad roads in the project area, especially during the wet season, limit economic activities in these villages.

From field observations, the following findings were made:

The number of people living in each household varies considerably between Bwari towns and other towns and villages within the project area.

Semi-skilled professionals, such as blacksmiths, emigrate from neighboring towns to the project area to take advantage of the high demand for farm implements during the farming season.

Land use practice in the project area is devoid of any cultural taboos.

Sale of land has gradually been introduced to the project area, especially Bwari Area Council where individuals are buying land and building houses to meet the growing demand for houses in the fast growing town.

The villages in Bwari Area Council are that fall within the project area are gradually becoming urban settlements.

There is an influx of people into the project area to seek employment.

**5.4.3 Socio-Economic Characteristics of Respondents**

In order to obtain and evaluate the socio-economic characteristics of the settlements within the designated project area, structural questionnaires were administered to various categories of people. Their responses have been classified as shown in Table 8. Major socio-economic variables considered include age, education, household size and distribution, occupation and income.

The average age of respondents was 43.3 years with a range of 24 to 65 year. Age distribution of respondents by communities in the project area did not show significant variability; hence average values were taken for all the respondents. On average, the majority (70.7%) of respondents were under 50 years of age, with the highest proportion of 33.4% falling within the 31-40 years age bracket (Table 10). However, the predominance of relatively old people above 50 years in the farming sector is observed in many parts of Northern Nigeria. This implies that farming is engaged in to a greater extent by the older people rather than younger people.

Educational attainment of the respondent showed that 22.2% did not attend formal school, while 35.6% spent between one and six years, 35.5% spent between seven and eleven years, while the rest (6.7%) spent above 11years- formal school (Table 8). The average number of years spent in school was 5.8 years.

Primary occupation of respondents is farming. Other occupation observed include trading, casual labour and civil service. The project has not caused any changes in occupation among the people. Four main sources of income were identified, namely, farm returns, proceeds from trading, salaries and wages, as well as cash gifts from friends and relatives. The income structure is shown Table 11 below;

**Table 10 : Socio-Economic Characteristics of Respondents**

| Range | Age | | Education | | | Income/Annum | | |
|---|---|---|---|---|---|---|---|---|
| | No | % | Range of years | No | % | Range(₦) | No | % |
| 21-30 | 17 | 18.5 | Zero | 20 | 22.2 | 5,000 or below | 2 | 4.2 |
| 31-40 | 31 | 33.7 | 1.6 | 32 | 35.6 | 5,000-10,000 | 6 | 6.7 |
| 41-50 | 17 | 18.5 | 7-11 | 32 | 35.6 | 10,000-15,000 | 16 | 17.8 |
| 51-60 | 21 | 22.8 | 12-above | 6 | 6.7 | 15,000-20,000 | 61 | 67.7 |
| 61-70 | 6 | 6.5 | | | | 20,001-above | 5 | 5.6 |

**(Source: WADSCO, 2004)**

**Table 11 : Occupational Distribution of Respondents Before and Since the Water Project**

| Primary Occupation | Before Water Project | | Since Water Project | |
|---|---|---|---|---|
| | No | %age | No | %age |
| Farming | 82 | 70.68 | 70 | 60.34 |
| Trading | 6 | 5.17 | 12 | 10.34 |
| Casual Labour (Farm Labour) | 8 | 6.89 | 14 | 12.06 |
| Civil Service | 7 | 6.03 | 8 | 6.89 |
| Fishing and hunting | 4 | 3.44 | 3 | 2.58 |
| Jobless/Applicants | 3 | 2.58 | 1 | 0.86 |
| Artisans | 6 | 5.17 | 8 | 6.89 |
| **Total** | **116** | **99.96** | **116** | **99.96** |

**(Source: WADSCO, 2004)**

### 5.4.4 Needs and Concerns of the Project Host Communities

Initially, information about the project and associated activities were out of the people's reach. The situation has now changed as our interview shows that all the villages including those not directly affected are aware of the project. They have, however expressed their desires about the project as follows:

**Resettlement:** Those to be displaced to be resettled and adequately compensated. This also includes crops affected during clearing of ground by the project.

**Farm Land:** The people around the Bwari axis of the project area have complained about limited farm land. They were thus unhappy that the project would further deplete the existing farm land.

**Employment of Indigenes:** The people would be happy if the project could provide opportunity for employment of their youths either permanently or on causal basis. This view was more expressed at the Kachia axis of the project area where the Upper Gurara Dam is being constructed.

**Irrigation Water:** Farmers want some of the water to be allocated for irrigation farming. This would enable them to engage in double cropping each year, in addition to irrigating the arid zones.

**Improvement of Infrastructure:** There was a general concern that the infrastructure in the villages was poor. It is the hope of everybody that through the project, the poor infrastructure in the villages will attract the interest of government during the course of the project.

### 5.4.5 Disease Prevalence in the Project Area

The disease considered in this study includes schistosomiasis (sleeping sickness), onchocerciasis (river blindness), cholera, diarrhoea, dysentery, guinea-worm, malaria and filariasis. With the exception of onchocerciasis, the other diseases were identified.

Cholera was reported in eleven out of twenty villages, and the casualty number was given as 32 since 1999. Cholera was reported to be non-seasonal. Diarrhoea was reported in all the villages with a total casualty of 154 since 1999. It is most prevalent in Pwambara, Ushafa, Peyi and Saminaka villages. It occurs during both rainy and dry season. Dysentery was also prevalent in all the villages with a reported casualty number of 296 since its inception in 1997. It was found to be more common during the rainy season, although casualty number was reasonably high during the dry season.

Other infections reported in the area include foot rot and skin diseases. These probably resulted from poor environmental habit as most farmers move about their farm herds bare-footed. As much as 39% of the respondents had suffered from these other infections. Majority (78%) of respondents reported that ill-health by these disease had affected their performance of farm-work.

### 5.4.6 Sources of Domestic Water

The main source of drinking water is the stream. In some of the villages however, pipe borne water is available. This could be found in some villages and settlement in Bwari Area Council. Water is also collected from ponds and none of the respondents boil their water before drinking. This largely explains the prevalence of some water-borne diseases in the area. Only 51 respondents from Anturu Awan, Angwa Toka, Tudun Wada, Ushafa and Peyi reported visiting the available clinic for treatment. In most cases, the available clinics do not have drugs, as a result of which patients patronize patent medicine dealers and herbalists. It was only in Bwari area that drugs were reported to be available and medical doctors were at hand to attend to patients. In other areas, herbalists were consulted for the treatment of such sickness as malaria, river blindness, diarrhea, dysentery, filariasis, cholera, and other ailments. Respondents gave little or no attention to preventive measures of disease infection.

**5.4.7 Infrastructural Services**

**5.4.7.1 Facilities**

Infrastructural services such as Transportation, Telecommunication, Educational and health services are scanty and in most cases not available. It is suggested that the few available facilities in some of the villages should be expanded while new ones should be provided in areas where none exist.

**5.4.7.2 Waste Management**

Given the terms of reference (TOR) of the project, this area focuses more on sewage system in the project area. Investigations show that there is no central sewage system. Consequently, there are no sewage treatment plants.

For human excreta, pit latrines, water system and open air (in the bush) area is the practice. In the semi urban areas in Bwari council headquarters, water sanitation systems exist. But in the peri-urban and rural area of Kachia axis, pit latrines and the open air methods are practiced.

For garbage or solid waste, it is observed that it is collected after compound sweeping and thrown into the surrounding bushes. Sometimes the waste is collected and burnt. This system may present problem in the future because the settlements are fast expanding.

**5.4.8 Public Meeting with Stakeholders**

Meeting were held with stakeholders in Kagarko L.G.A., Kachia L.G.A. and Bwari Area Council on June 26$^{th}$ 2002, July 5$^{th}$ 2002 and August 8$^{th}$ 2002, respectively.

In attendance at the meeting were representatives of the Employer (FMWR), the Consultant (WADSCO), FCT Water Board, Abuja Environmental Protection Board, Chiefs and Community leaders of the affected communities.

The purpose of this meeting was to discuss the impact of the project on the environment and to obtain views and contributions from stakeholders on the execution of the project.

**5.4.8.1 Summary of Expectations of Stakeholders**

**Kagarko L.G.A. of Kaduna State**

- Provision of potable water for the communities within the project area.
- Electricity Supply.
- Provision of irrigation facilities along the pipeline route.
- Provision of health facilities e.g. health clinics and dispensaries.
- Provision of road: specific roads mentioned;
    - Dam-Kwaten-Kutaro-Kagarko.
    - Akoti-Kushe Atakaranto-Kasan Gwai.
- Reforestation
- Employment of youths of the affected communities by the companies undertaking the execution of Gurara Water Transfer Project.
- Provision of Educational facilities-schools (Primary, Secondary and Tertiary Institution).
- Settlement/villages near the reservoir to be resettled and compensated, the major reason being that the water table in these areas would be high and these communities would be affected.

**Kachia L.G.A. of Kaduna State**

- Provision of roads within the project area.
- Electricity supply to the affected communities.
- Pipe borne water to the communities and the Local Government Headquarters. Installation of a water treatment plant at Kachia town.
- Educational facilities-schools (Primary, Secondary and Tertiary Institutions)
- Markets to be provided at the resettlements
- Provision of Health facilities-Health Clinics and Maternity homes.
- Recreational facilities.
- Employment of youth of the area by contractors handling the GWTP.
- Payment of compensation to those whose farmlands were destroyed.
- Resettled villages to be close to the reservoir.
- Provision of farm lands for the resettled people.
- Provision of irrigation facilities within the project area.

**Bwari Area Council FCT**

- Provision of potable water in Bwari town and the rest of the towns and villages within the projects area.
- Employment of youths of the affected communities by contracting companies and the FCT water board.
- Provision of Educational facilities-Primary and Secondary Schools.
- Compensation for houses and farmlands destroyed in the course of executing the project.

## 5.5 Associated and Potential Environmental Impacts

### 5.5.1 General Environmental Impacts

There are several positive and negative environmental impacts associated with dams and reservoirs. The benefits of a dam project are flood control and the provision of a more reliable and higher quality water supply for irrigation, domestic and industrial use including hydroelectricity generation. Intensification of agriculture locally through irrigation can reduce pressure on un-cleared forest, wildlife habitats, and areas suitable for agriculture elsewhere. In addition, dams in the project would create a reservoir for fishery activity and the possibilities for agricultural production on the reservoirs draw-down area.

On the contrary, large dam projects such as the GWTP cause irreversible environmental changes over a wide geographical area. The area of the influence extends from the upper limits of the catchment of the reservoir to as far down stream of the estuary, coastline and offshore zone. It includes the watershed and river valley below the dam. While there are direct environmental impacts associated with the construction of dams, the greatest impact result from the impoundment of water, flooding of land to/from the reservoir and alteration of water flow downstream. These effects have direct impacts on soil, vegetation, wild life, fisheries, climate and especially the human population in the area.

The dam's indirect effects, which on occasion may be worse than the direct effects, include those associated with the building, maintenance and functioning of the dam (e.g. access roads, construction camps, power transmission lines). Agricultural, Industrial or Municipal developments are made possible by the dam.

### 5.5.2 Significant Positive and Negative Impacts

#### 5.5.2.1 Impact on Settlement

Gurara Water Transfer Project, as expected, would lead to displacement of settlements due to the wide expanse of land required in such a project. During our environmental assessment survey, we identified settlements/villages/communities to be submerged within the reservoir area or otherwise affected, over the dam site and along the pipeline route. We also ascertained the size of farmland and economic trees to be submerged by the reservoir and dam and as well as those that would be cleared along the pipeline route.

#### 5.5.2.2 Impact on Vegetation and Wildlife

Environmental Impact on vegetation and wildlife as a result of the Gurara Water Transfer Project (GWTP) has been assessed, quantified and evaluated.

The environmental impact of this inter-basin water transfer project on vegetation and wildlife, still at the project implementation stage, is represented under three categories, namely:

- Impact upstream of the dam, i.e. on the inundated land surfaces and environs.
- Impact on downstream areas of the dam, including the pipeline route.
- Impact on area around Lower Usuma Dam.

### 5.5.2.3 Impact Upstream of Dam (Reservoir)

The three kilometer (3km) long Gurara dam is expected to impound water and create a reservoir of some 50km$^2$ in area. This expanse of water would cause habitat changes for vegetation and wildlife already established within the area.

The vegetation of Akwana West and East forest reserves would be cleared off to make way for the reservoir. Old, weak and young wildlife would be drowned. The soil pH would be reduced because of increased decomposition of organic matter which according to Adejuwon (1995) would render some cationic elements unavailable to plants. In addition, drowned vegetation would increase methane and hydrogen sulphide content of the lake; making the aquatic environment anaerobic and reduce the oxygen demand of decomposers and other aquatic organisms within the first year of the lake formation.

Furthermore, the lake and its immediate vicinity would be invaded by a large number of aquatic plant and animal species. Water weed such as *Polygonum salcifolium, Commelina diffusa, Pistia stratoites and Echinochloa pyramidalis and Water hyacinth. Eichhornia crassipes* can be expected to flourish on the lake and its immediate vicinity. Macrophytic aquatic plants like *Typha spp, Nymphea spp and Juseae spp: Phytoplanktons such as Cyanophyceae* (blue green algae) and diatoms including *Spirogyra and Bryophyilm* could also colonize the lake and its environs. Increased human population and noise from construction and operation of the dam would scare away wildlife. In other words, at the terrestrial level, the population of wildlife would generally be reduced.

**Table 12: Summary of Impacts of the Project on Vegetation and Wildlife Upstream of Dam (Reservoir Area)**

| **Positive Impacts** | **Negative Impacts** |
|---|---|
| 1. Increase in the ground water table associated with the new lake. | 1. Drowning of vegetation by impounded water. |
| 2. Influx of rich and dense vegetation characterized by rain forest species. | 2. Most able bodied wildlife would migrate out of the lake position, while the old, weak and young ones would be drowned. |
| 3. The forest species established would form a sanctuary for wildlife and serve as wind breakers as well as firewood for human use. | 3. Reduction in water pH because of increased decomposition of organic matter. |
| 4. Increase in the population of aquatic fauna especially fish species. | 4. Increase human population and noise from construction and operation, if the dam would scare away wildlife. |
| | 5. Drowned vegetation would introduce methane and $H_2S$ into the lake and reducing |

| | |
|---|---|
| | the oxygen content and other aquatic organisms. |
| | 6. The area occupied by the reservoir will be a loss of habitats to wildlife due to a change in landuse. |
| | 7. The newly created lake would act as a barrier to the migratory pathway of some terrestrial wildlife species. |
| | 8. Terrestrial wildlife would be drastically reduced. |
| | 9. Disease vectors like mosquitoes, snails, black flies e.t.c. would invade the periphery of the lake. These vectors would transmit malaria, flariasis e.t.c. |

**(Source: WASDCO 2004)**

#### 5.5.2.4 Impact in the Downstream Area Including Pipeline Conveyance

From our observations and analysis, the impact of GWTP on vegetation and wildlife would be two-fold. In the first place, there would be stream channel contraction downstream of Gurara River. This effect would be particularly pronounced downstream of the dam to the tributary river passing Saminaka. Secondly, the impact of the pipeline route on vegetation and wildlife would severely disrupt familiar habitats.

Clearly, the entire project area is effectively drained by stream network upon which vegetation and wildlife area deeply dependent. Consequently, along the immediate stream banks, vegetation growth would be negatively affected because of soil deficit. A change in wildlife population would result from the stream contraction. The opening of the area through the creation of pipeline route exposes wildlife to more human contact, noise and depletion of food source. Wildlife would lose not only their breeding site and sanctuary, but also their natural habitats because of the fragmentation of protective vegetation. Population of the more endangered species, including antelopes, monkeys, warthogs, grass-cutters and rabbits, would be severely depleted through hunting and out-migration of the animals.

**Table 13 : Summary of Impacts of the Project on Vegetation and Wildlife Downstream Areas including pipeline Conveyance**

| Positive Impact | Negative Impact |
|---|---|
| Flood Control: Most of the flooded lands will be recovered due to contracti6n of the main stream | **Reservoir**<br><br>Vegetation growth would be negatively affected because of soil moisture deficit associated with stream channel contraction.<br><br>The more open vegetation would reduce wildlife population.<br><br>The clear water flowing downstream having lost its sediments to the lake, would lack enough nutrients for fish and other aquatic biota. |
| Most arable land would be made available downstream due to channel contraction of the main stream. Such lands if undistributed would regenerate true guinea savannah vegetation. | **Pipeline Route**<br><br>a. Clearing all plant species along the pipeline route to the ground level.<br><br>b. The pipeline route would provide a corridor through which people would have easy access to the forest reserves, for more aggressive exploitation of wood fuel and timber.<br><br>c. Wildlife would lose breeding sites and sanctuary. Natural habitats would be destroyed and exposing wildlife to more danger from hunters. |
| An increase in the population of terrestrial wildlife is expected with increase in vegetation growth downstream of dam. | |

**Source : WADSCO (2004)**

**Table 14 : Summary of Impacts of the Project on Vegetation and Wildlife Around Lower Usuma Dam**

| **Positive Impacts** | **Negative Impacts** |
|---|---|
| There would be steady maintenance of groundwater table due to the sustained availability of water from the Gurara dam. | Burrowing wildlife that inhabit the immediate vicinity of Lower Usuma Dam/Reservoir during the dry season would simply upwards, further away from unusually wet soil during the dry season around the lake periphery |
| Increased moisture from the Upper Gurara dam would further encourage thick forest growth. | |
| A gradual increase in the structural composition of plant species presently covering the Usuma forest reserve would take place towards its Northern boundary. | |
| There would be an increased population of wildlife in the vicinity of Lower Usuma Dam area. | |
| Higher population of fish, zooplankton, Phytoplankton and macrophytes are expected because of sustained supply of water from the Gurara Reservoir. | |

**Source: WASDCO (2004)**

### 5.5.3 Site preparation and Construction Impacts

Pipeline route construction proposals have until very recently, always centered on engineering and economic considerations. However, it is now generally accepted that environmental impacts of conveyance pipeline and dam construction on land resources should also be of concern. There are both favourable and unfavourable impacts of Gurara project pipeline construction on the project area.

Pipe route construction provides all-weather access required in the management of the project resources and enables undisturbed flow and transfer of river water from upper Gurara for treatment and steady supply of potable drinking water to the FCT and environs.

Unfavourable impacts will always be highlighted under two subheadings; primary impacts and secondary impacts. Secondary impacts are a result of primary impacts.

Primary impacts:

- Removal of vegetative cover (deforestation)
- Possible foreclosure of exploitation of other land resources (e.g. minerals) that may exist underground
- Sand filling part of some wetlands and swampy areas which are valuable for their wood, other animal species and their protective functions.
- As a result of the access provided by the pipeline routes through some of the land resources, uncontrolled immigration of people in search of land for farming or other resources is almost inevitably stimulated. The access creates opportunity for erosion (wind or water)

Secondary impacts:

- Reduction of future supply of timber and other forest products.
- Destruction of biological diversity or loss of important flora and fauna (particularly threatened and endangered species).
- Loss of important habitat for ecosystems.
- Interference with movements of wild life.
- Poaching pressures increased because of access provided by pipeline route construction.
- Loss of watershed protection problems for dams and irrigation systems served by such watershed.
- Change in ground water levels as a result of high rate of evaporation from exposed land.
- Reduction or elimination of grazing lands
- Ability of wetlands to control flooding is reduced where such wetlands have been partly sand filled.
- Stagnant water bodies from ditches which serve as breeding ground for water borne diseases.
- Land use changes, resulting from the uncontrolled accessibility are often unsustainable due to land use inappropriate to the type of management for land resources in the environment.
- Loss of existing and future land uses as productivity is degraded resulting from the use of the physic-chemical properties of the soils
- Loss of sensitive habitats (e.g. wetlands and mangroves)
- Interference with range lands as in the case of places cleared of closed forests which do not maximally support domestic ruminants and wild herbivores.
- A decline in rangeland productivity through natural (e.g. climate) or human driven forces will have negative impact on family income, health and the distribution of scarce resources between people

**5.5.4 Socio-Economic Impact**

#### 5.5.4.1 Existing Condition

River Gurara, traversing many hectares of farms, arable lands and human settlements, is a major factor in the promotion of life-giving and life-sustaining environment. Seasonal flooding of the areas drained by Gurara River is a unique resource endowment which creates FADAMA conditions for rice cultivation and suitable soil/topographic qualities for other farming ventures.

As would be expected, these natural qualities, made possible by Gurara flooding, attracted people skilled in FADAMA based agricultural production. They also provide a haven for livestock farmers.

In most of the villages and communities covered by the project, emigration of young men and women is relatively low. The attractions of the town or urban life have not taken root. Even the very few who manage to get low-paying jobs like security, gate-keeping, messenger and factory hands, are more of rural dwellers who commute to work daily at the Federal Capital Territory, Abuja.

The atmosphere in most of these communities exudes self- confidence, contentment and general contempt for urban or town life. In the same vein, education is not accorded much priority in the scheme of thing. This is because the challenges of the local population do not depend on western education. As long as Gurara River is overflowing its banks and floods the lands, farming is guaranteed and to that extent, there is generally little dependence on external variables.

#### 5.5.4.2 Post-Dam Construction Socio-Economic Impact

The socio-economic impact of water transfer project derives from the expected decline in the aridity, acreage in FADAMA cultivation and consequently, income of the farmers. It is expected that the project, when completed, will conform to the general hydrologic principle which sees the drainage basin as a system (Chorley. 1969) where events or activities in on part have serious functional repercussions over other parts.

The rice bowl economy and the general cash crop and livestock farming activities in the study area are a result of the specific and general location of the area that is downstream on River Gurara, and the sudano-sahelian ecology of the area.

By virtue of these specific and general conditions, the rice economy is sustained by the FADAMA setting. The seasonality of the flood is due to the climate pattern of the general area which has two distinct periods with respect to water availability. The first period is long and dry, and of little hydrologic and agricultural importance to the general area. The second period is shot and wet (usually June-September) and characterized by much agricultural activity. These conditions release of water including annual flooding will be reduced in response to this man-made hydrological modification in the area. This result will be a reduction in the farm acreage and some decline in agricultural production. The successful damming of the river is likely to result in the change of the hydrologic regime, thus, altering flood-based agriculture. Experience from dam projects supports this scenario.

There is no reason to believe that the Upper Gurara Water Transfer Project (GWTP) will be much different. This is especially the case when it is remembered that while most dams are designed to improve irrigation, and so enhanced agricultural production, the Upper Gurara Water Transfer Project is designed primarily to supply water, through conveyance pipe to the existing Lower Usuma Reservoir for the benefit of the Federal Capital Territory in addition to enhancing agricultural production and generation of electricity. However, the GWTP will most likely open up the rural areas around the Kachia axis. In addition to the tourism potential of the project, increased human and vehicular traffic shall have a positive effect on the people, and usable roads are already traversing the area.

**Table 15 : Summary of Impacts of the Project on the Economy**

| Positive Impacts | Negative Impacts |
|---|---|
| Increase in fish production: This will naturally attract more income to residents | Loss of arable lands for crop and animal production. |
| Enhanced employment opportunities among the youths | Reduction in the supply of fuel wood and other forest materials. |
| The project will attract not just fishermen and farmers, but also traders in agricultural products and merchandise, thus encouraging additional commerce in the project area | Loss of opportunities to exploit other land resources like minerals that may exist under the dam and reservoir area. |
| Improved economic setting in area of education, housing, food e.t.c. | Reduction in fadama farm lands. |

**Source : WASDCO (2004)**

### 5.5.5 Project Impacts Envisaged on Geological and Hydrological Environment

Envisaged impact will occur in three distinct project areas namely:

- The area engulfing Gurara dam during and after construction of dam and reservoir filling.
- The environment around Lower Usuma Dam arising from increased water level in the lake/ reservoir.
- The immediate vicinity of the pipeline route during and after construction of connecting pipeline.

The nature and severity of impact would be zone specific but would generally include disruptions of:

- Hydrological System.
- Erosional Balance.
- Groundwater Flow System.
- Water Source Quality.

**Hydrological System**

Common indicators of the level of activity in the hydrologic system include:

- Infiltration capacity
- Soil moisture deficit
- Hydrograph form
- Water discharge
- Flood frequency
- Sediment load
- Scour depth
- Percentage of vegetation cover on banks, etc.

Scientific data pertaining to baseline values of these parameters are not reliable. However changes that would arise from the project (during and after construction phase) in the vicinity of the dam/reservoir would be both positive and negative. The filling of the reservoir would disrupt the hydrological balance. At the upstream end, a new base level for local streams would be formed while increased erosion (normally associated with headstreams) could occur downstream. The differential water level between the Reservoir Lake and adjacent downstream areas would lead to increased soil moisture and differential hydraulic potentials. This would result in ground water seepage, especially in unprotected slopes and formation of diffuse flows and springs downstream. Increased soil moisture would encourage vegetation growth and thus agriculture. However, the flux of groundwater could be associated with both internal and external erosion. Such erosional phenomenon would be minor and negligible as the in-situ regolith is structurally stable. Where the regolith (in-place) has being disturbed, their stability may be reduced. It is recommended therefore to establish the stability of all artificially generated slopes to be created by the project. In general, the changes in the drainage and other hydrological characteristics of the terrain arising from the project would be negligible or affect the environment in a positive sense.

## 5.6 Mitigation Measures

### 5.6.1 Mitigation of Negative Environmental Impacts on Settlement

In order to mitigate environmental impact on settlements, the following procedures were taken:

- Size of settlement was ascertained through topographic and perimeter surveys.

- An evaluation for compensation for all structures, economic trees and crops to be affected by the project.

**Table 16 : Mitigation Measures for negative impacts on vegetation and wildlife**

| Impacts | Mitigation measures |
|---|---|
| Drowning of old, weak and young wildlife | These animals to be tracked down, captured alive and liberated to safe distances away from the reservoir |
| Reduction in fish species downstream of the dam | With associated flood control by the dam, the project area can be converted to barrage fish ponds. More fish species to be introduced into the new lake |
| Invasion of the dam environment by disease | Biological control is recommended. |
| Flooding of unintended area | Erection of saddles to check uncontrolled inundation |
| Reduction in volume of water downstream that could lead to loss of important fauna. | Construction of fish ponds and releasing a steady volume of water to balance flora and fauna within the habitats. |
| Loss of arable land to the reservoir | Afforestation in suitable areas upstream and/or downstream of the dam |

**Source: WASDCO (2004)**

### 5.6.3 Impact and mitigation measures

The detailed potential negative impacts on the environment vis-à-vis the mitigation measures discussed above are summarized in Table 15.

**Table 17: Summary of the potential Negative Impacts and the Mitigation Measures**

| S/No | Potential Negative Impacts | Mitigation Measures |
|---|---|---|
| | Negative environmental effects of construction;<br><br>Air and water pollution from construction and waste disposal;<br><br>Soil erosion and destruction of vegetation, sanitary and health problems from construction camps | Measures to minimize impacts:<br><br>Air and water pollution control; careful location of camps, buildings, borrow pits, quarries, and spoil and disposal sites. Precautions to minimise erosion, land reclamation and containment of wastes from camp sites. |
| | Dislocation of people living in | Relocation of people to suitable area, provision of compensation in cash and kind |

| | | |
|---|---|---|
| | inundation zone | for resources lost, provision of adequate health services, infrastructure and employment opportunities. |
| | Loss of land (agricultural, forest range, net lands) by inundation to form reservoir. | Introduction of irrigated agriculture |
| | Loss of historic, cultural or aesthetic features by inundation. | Historical and cultural monuments to be relocated |
| | Loss of wilderness and wildlife habitat | Establishment of compensatory parks or reserved areas; rescue and relocation |
| | Proliferation of aquatic weeds on reservoir and downstream areas, impairing dam discharge; irrigation systems; navigation and fisheries and increasing water loss through transpiration | Clearance of woody vegetation from inundation zone prior to flooding (nutrient removal); provide weed control measures; harvest of weeds for compost, fodder of biogas; regulation of water discharge and management of water levels to discourage weed growth. |
| | Deterioration of water quality in reservoir | Clearing of woody vegetation from inundation zone prior to flooding;<br><br>Control of land use, waste water discharges, and agricultural chemical use in watershed |
| | Sedimentation of reservoir and loss of storage capacity | Control land use in watershed (especially conversion of forests to agriculture);<br><br>Reforestation and/or soil conservation activities in watersheds (limited effect), and hydraulic removal of sediments (flushing, slicing, release of density currents). |
| | Formation of sediment deposits at reservoir entrance creating backwater effect, flooding and water logging | Sediment flushing, slicing. |

| | | |
|---|---|---|
| | upstream. | |
| | Decrease in flood plain (recession) agriculture. | Design of trap efficiency and sediment release (e.g. sediment flushing, slicing) to increase silt content of released water. Introduction of irrigated agriculture |
| | Disruption of riverine fisheries due to changes in flow, blocking fish migratory pathways, and changes in water quality and limnology | Maintenance of at least minimum flow for fisheries; provision of fish ladders and other means of passage; provision of protection of spawning grounds, aquaculture and development of reservoir fisheries in compensation. |
| | Increase of water-related diseases | Design and operation of dam to decrease habitat for vector.<br><br>Biological Vector control. |
| | Conflicting demands for water use | Planning and management of dam in context of regional development plans; equitable allocation of water between large and small holders and over geographic regions over the service area. |
| | Social disruption and decrease in standard of living of resettled people | Maintenance of standard of living by ensuring access to resources at least equalling those lost; provision of health and social services. |
| | Environmental degradation from increased pressure on land | Choice of resettlement site to avoid surpassing carrying capacity of the land.<br><br>Increase of productivity or improved management of land (agricultural, range, forestry improvements) to accommodate higher population. |
| | Disruption/destruction of communities | Avoid dislocation of the culture and values of communities. Where not possible, relocate an area allowing them tom retain lifestyle, customs and values. |
| | Increase in humidity and fog locally, creating favourable habitat for insect | Biological vector control. |

| | | |
|---|---|---|
| | disease vectors (mosquitoes, tse-tse fly) | |
| | INDIRECT | |
| | Uncontrolled migration of people into the area, made possible by access roads and transmission lines | Provision of rural development and health services to minimize impact on the project area |
| | Environmental problems arising from development made possible by dam (irrigated agriculture, industries, municipal growth) | Basin-wide integrated planning to avoid overuse, misuse, and conflicting uses of water and land resources. |
| | EXTERNAL | |
| | Poor land use practice in catchment area resulting in changes in water quality. | Land use planning efforts which include watershed area upstream of dam |

**Source: WADSCO (2004)**

## 5.7 Environmental Management Plan

### 5.7.1 Introduction

The monitoring of environmental impacts is an essential part of the EIA process. The aim is to detect whether an impact has occurred or not, and if so to determine its magnitude or severity and secondly, to establish whether the recorded impact is actually the result of the project and not caused by other factors.

### 5.7.2 Scope of monitoring

The scope of the monitoring plan/programme covers selected direct and indirect impacts due to project location/route, construction and operation. These shall coverall components of the project namely: the dam, the reservoir, pipe manufacturing factory and the pipeline route. Contingency crisis management procedures shall be implemented to prevent or reduce the deterioration of the environment due to the project.

### 5.7.3 How Monitoring Programme would be implemented

It is necessary to set up a well-equipped monitoring unit within the Federal Ministry of Water Resources or the agency that would operate and manage this project. Such units would be directly responsible for monitoring the environmental impacts of the project. Personnel involved shall comprise Environmental Scientists, Field Technicians and Socio-economists. This unit would become operational from the construction stage of the project and would liaise with and involve residents of the project area, non-governmental environmental action groups and other regulatory authorities.

Monitoring should be done by field observation and recording of selected parameters. The field data would be analysed and evaluated to determine the nature and degree of changes and to establish if they are project related. There would be regular sensitization of identified stakeholders by audio-visual media about related environmental issues and the workings of the project.

**5.7.4 Parameters to monitor**

Parameters selected for monitoring are both environmental and socio-economic.

For the dam and reservoir, the following parameters should be monitored;

- Rainfall
- Stored water volume in the reservoir
- Annual volume of sediment transported into reservoir
- Water quality data at dam discharge and at various points along the river (data to include salinity, pH, temperature, electrical conductivity, turbidity, dissolved oxygen, suspended solids, phosphates, nitrates)
- Hydrogen sulphide, and methane generation behind dams
- Limnological sampling of microflora, microfauna, aquatic weeds, and benthic organisms
- Fisheries assessment surveys (species, population, etc.) in the river and reservoir
- Wildlife (species, distribution, numbers)
- Vegetation changes (cover, species, composition, growth rates, biomass, etc. in the upper watershed, reservoir draw-down zone and downstream areas)
- Increases in erosion over the watershed
- Impacts on wildlife, species or plant communities of special ecological significance
- Public health and disease vectors
- In and out migration of people to the area, and
- Changes in economic and social status of resettlement populations and people remaining in the basin

For the pipe manufacturing factory, parameters shall include,

- Safety procedures in conformity with international guidelines and codes for the prevention and treatment of fire and explosion hazards in the factory during production;
- Disposal of wastes from the factory processes including scrap metal cuttings, waste bitumen products, as defined by local or international standards.

For the pipeline route, additional parameters to monitor shall include:

- Change in traffic due to construction of service and access roads;
- Incidents of injury/loss of life from accidents
- Hazards from pipeline leakage and rupture;
- Resultant secondary developments (e.g. squatters) within the pipeline Right of Way (ROW);
- Changes in drainage pattern
- Increased access to wild lands, historic sites, sacred sites, etc.

**5.7.5 Methodology.**

For climatological parameters such as rainfall, temperature, fully equipped weather stations should be set up at Upper Gurara dam site, Engineers camp at Chinka and at Lower Usuma dam site.

Hydrological data should be monitored at gauging stations just downstream of Upper Gurara dam and major stream crossings along the pipeline route at Amfani, Pego, Passini, Bwari, and Lower Usuma Dam.

Vegetation, wild life and land use data would be collected at villages along the pipeline route. Population and economic data would be collected at villages along the pipeline route and the resettlement areas.

**5.7.6 Monitoring Schedule**

Monitoring of the selected parameters would begin with initial baseline study data, which would continue through the construction and operational periods.

Climatological parameters would be measured daily from construction through project operation. Hydrological data would be collected twice a year namely; during the rainy and dry seasons throughout the construction and operation stages. Vegetation, wildlife and land use data would be collected during the rainy and dry seasons throughout the project life. Population and economic data would be collected at longer intervals, say every five years, or when the census is being carried out. Health Safety and Environmental (HSE) records shall be monitored for the pipe manufacturing factory as lay down by internationally recognized standards.

## 5.8 Remediation Plans after decommissioning/closure

The project is designed for a life span of 50 years even though in reality project components would last longer than this period and different components would be phased out at varying times.

Decommissioning or temporary closure of the project can occur for many reasons such as accidents or economic reasons.

In the event of a dam breach or pipeline burst, contingency plans have to be made to mitigate the disastrous effects on lives and the environment. Intensive monitoring of encroachment into pipeline right of way, and the downstream valley of River Gurara shall be done to check illegal encroachment. Supply level at the Lower Usuma Dam should always be kept at a minimum to provide standby supply in event of shortage or cut-off of supply from Gurara Reservoir.

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# Module 5:

# CONFLICT RESOLUTIONS AND COMMUNITY INVOLVEMENT IN RIVER BASIN MANAGEMENT

**COURSE OBJECTIVES/AIM/ LEARNING OBJECTIVES**:

This course is mainly a training of trainers focusing on conflict resolution and community involvement in river basin management under the framework of Integrated Water Resources Management (IWRM). Attention is given to water resources issues, IWRM, conflict analysis and resolution instruments and community involvement in river basin management. The implications for sustainable water management will be also addressed. Emphasis is given on practical examples of issues in the African region in order to share experiences. The sessions are designed to be interactive to bring out varied experiences.

At the end of the course participants will be able to:

- Link water resources issues with IWRM and conflict resolution in water resources management;
- Identify factors that can escalate conflict with stakeholders and also factors that can prevent conflict;
- Apply a variety of conflict resolution skills for effective participatory, consensus building, and conflict management processes in water resources management;
- Design and facilitate community participation process, as is needed in river basin management;
- Identify and select appropriate techniques for a participatory process;
- Design river basin water user organizations and frameworks for action.

**COURSE CONTENT/SYLLABUS**

- Overview of hydrological cycle and water resources
- Introduction to Integrated Water Resources Management (IWRM)
- Understanding conflict and nature of conflict over water resources;
- Approaches to conflict management;
- Community involvement in river basin management;
- Case studies and activities.

**TARGET GROUPS AND LEVEL OF TRAINING**

The manual is designed to be interactive in nature with case studies and activities to stimulate discussion and allow for sharing experiences with and among participants. Participants are expected to facilitate some sessions of the training as a role play to gain first-hand experience which will also bring out the relevance of some of the topics. Targeted participants are expected to be drawn from active players in international, regional and/or country programmes and projects and are ideally in a position to take the training forward at the country level. They are expected to be active in the following categories:

- Water Resources Managers;
- Administrators of Water Basin Managements;
- Policy Makers in Ministries and Parliaments;

- Engineers, Hydro-geologists & Hydrologists;
- Researchers and Academics involved in training and research in WRM,
- Scientific Officers, Senior Technicians & Technologists;
- Water Resource practitioners in the Private Sector & CSOs.

**TEACHING METHODS/DIDACTICS TO BE USED:**

- Interactive teaching;
- Case studies and activities;
- Discussions;
- Role play;
- Field trips

**DURATION SUGGESTED–**5 days

**List of Acronyms**

| | |
|---|---|
| ADR | Alternative Dispute Resolution |
| CoE | Centres of Excellence |
| DR | Democratic Republic |
| EU | European Union |
| FAO | Food and Agriculture Organization of the United Nations |
| F MWR | Federal Ministry of Water Resources |
| GWP | Global Water Partnership |
| IPCR | Institute for Peace and Conflict Resolution |
| IWRM | Integrated Water Resources Management |
| KYB | Komadugu -Yobe Basin |
| LCBC | Lake Chad Basin Commission |
| MDG | Millennium Development Goal |
| NGO | Non-Government Organization |
| NOSR | Netherlands Organization for Social Research |
| NWRI | National Water Resources Institute |
| RBO | River Basin Organization |
| RWSSC | Rural Water Supply and Sanitation Centre |
| SCF | Stakeholder Consultative Forum |
| TAC | Technical Advisory committee |
| UN | United Nations |
| UNICEF | United Nations Children Funds |
| UNEP | United Nations Environment Programme |
| NEPAD | New Partnership for African Development |
| UNESCO | United Nations Educational Scientific and Cultural Organization |
| WUA | Water User Association |

**Acknowledgements**

This training manual was developed by Dr. Martin O. Eduvie, Engr. Sani D. Ahmed and Dr. D. Bashir of the National Water Resources Institute (NWRI), Kaduna, Nigeria. The encouragement of the Management of the National Water Resources Institute, Kaduna-Nigeria is highly acknowledged. The outline of the content and case studies was prepared as an outcome of a planning workshop for Joint Curriculum Development on the subject organized by the CoE and EU. The manual content has greatly benefited from existing materials developed for training and field staff guidance by Cap-Net and Institute for Peace and Conflict Resolution (IPCR).

Main material sources used and adapted include:

- Integrated Water Resources Management for River Basin Organizations by Cap-Net and UNDP, June, 2008 (www.cap-net.org)
- Conflict Resolution and Negotiation Skills for Integrated Water Resources Management by Cap-Net and UNDP, July, 2008 (www.cap-net.org)
- Mainstreaming Peacebuilding in Development Programming in Nigeria: Framework by IPCR and UNICEF, Nigeria, 2006

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This training covers the basics of conflict resolution and community involvement in river basin management under the framework of Integrated Water Resources Management (IWRM). For this reason IWRM principles and an overview of the water cycle are necessary although these notions already addressed in detail in Module 1 and Module 2 of this Western CoE Joint Training Course. Their inclusion to this Module allows for a stand-alone training module.

# 1.0 OVERVIEW OF HYDROLOGICAL CYCLE AND WATER RESOURCES

**Learning Objectives:**

At the end of this chapter, participants are expected to be able to:

- Understand basic concepts of hydrological cycle and terms relating to water resources;
- Appreciate water resources potential in Africa;
- Comprehend global and African water resources challenges.

## 1.1 Hydrological Cycle

The water cycle or hydrological cycle is a continuous process that has neither beginning nor end. It describes the continuous movement of water on, above and below the earth's surface. The hydrologic cycle processes are shown in Figure 1.

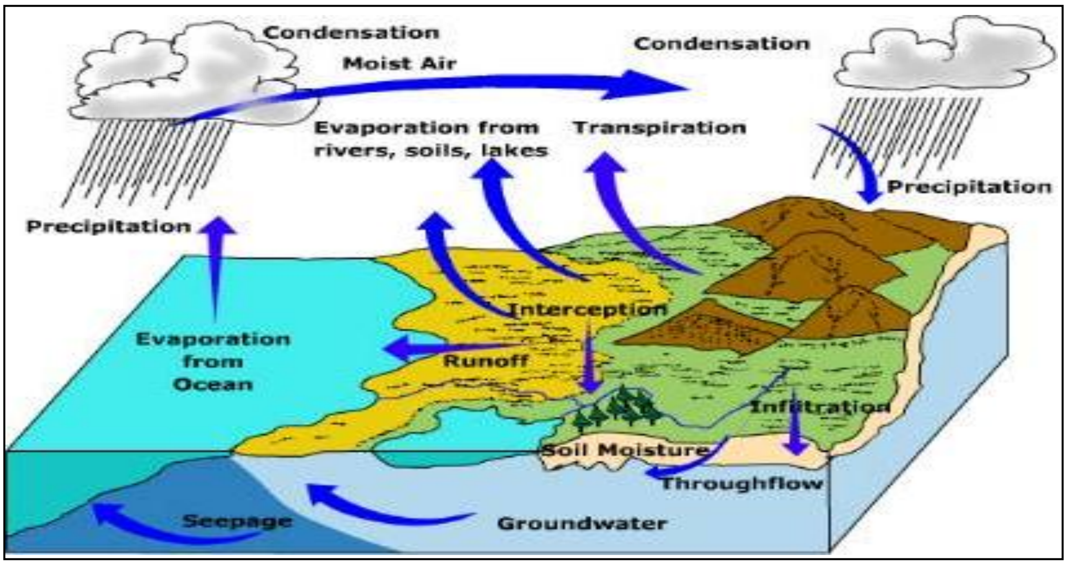


**Figure 1: Hydrological cycle**
**(Source: RWSSC, 2010)**

Driven by the energy of the sun, water evaporates from the sea, other surface water bodies such as lakes and rivers, and from other sources such as vegetation, soil, snow and ice. Evaporation of water occurs when the physical state of water is changed from a liquid state to a gaseous state (vapour). When water in the form of vapour evaporates into the atmosphere, it cools and forms tiny droplets, which can coalesce into clouds and fall as precipitation such as rain, snow or ice particles (hail). Precipitation may fall into a water body or it may fall onto a land surface. The water is then dispersed in several ways. It can flow back directly into a water body and ultimately back into the ocean, it can evaporates straight back into the atmosphere, remain on the surface, or be intercepted and captured by vegetation. It may also penetrate into the soil and flow through the soil horizon and into rocks below as groundwater storage. Some soil and groundwater also flows directly into rivers or streams. This is called base flow, and it is the reason why some rivers can continue to flow during dry weather.

When precipitation reaches the land's surface, it separates into two basic components:

- green water (evaporated) flow which supports the terrestrial ecosystems; and
- blue water (liquid) flow which supports aquatic ecosystems and is directly accessible for societal use.

Green water flow reflects water consumption by forests, grass lands or other vegetation cover. This flow generally sustains all terrestrial ecosystems and in particular for humans, rain fed crop production.

Blue water flows by gravity and moves across the land as runoff or infiltrates and migrates through the subsurface in ground water aquifers where it may also discharge into surface water courses. Blue water is accessible for societal use. Figure 2 shows the movement of blue and green water.

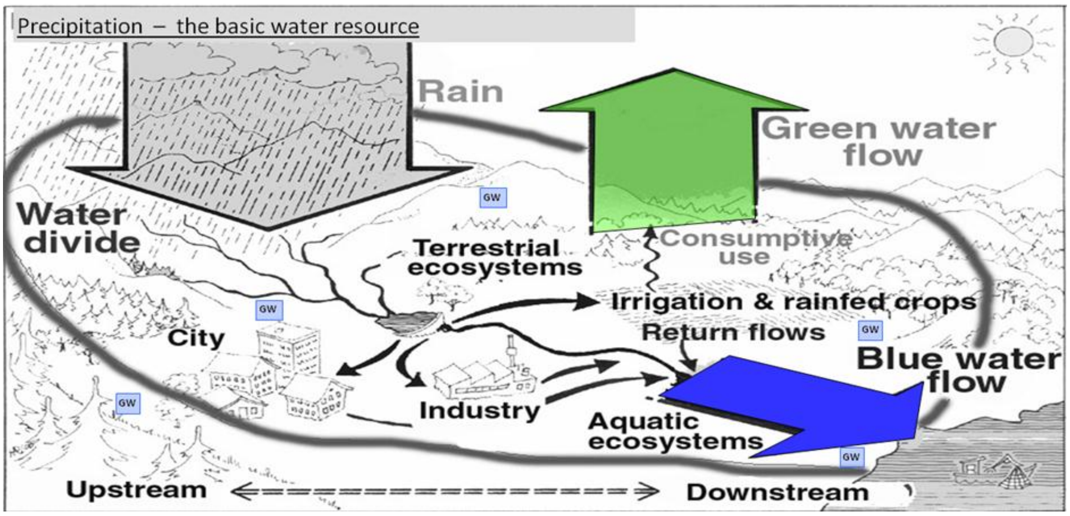


**Figure 2: Blue and Green Water Concept**
**(Source: Falkenmark, 2003)**

Hydrological cycle dynamics regulate the amount of water in freshwater ecosystems and the availability of water in terrestrial ecosystems, which is potentially a limiting factor for vegetation and groundcover development. Therefore, water is one of the major driving forces for ecological processes at the catchment scale.

## 1.2 Water Resources

The term, "water resources", can be understood as meaning the quantity of water expressed in units of weight or volume being accumulated either in aquifers (ground water resources) or in lakes and rivers (surface water resources) (UNEP-IETC, 2002). This can also include long-term storage such as annual snowpack and glaciers. Water resources are the product of the hydrological cycle and depend on precipitation and land surface conditions for run-off, infiltration, and ground water storage. They are influenced by the artificial impacts that result from human activities such as artificial infiltration or reservoir storage.

Groundwater constitutes an important source of water for domestic, industrial and agricultural uses. As a water resource, it presents several technical and exploitation advantages as follows:

- It is historically more stable from both a quantity and quality standpoint,
- In many instances, it provides good quality water with relatively consistent, low treatment costs,
- Its development and expansion can be launched more readily with lower initial investment costs,

However, the intensity of groundwater use has led to the emergence of many groundwater-dependent activities, and their future is now threatened by aquifer depletion and pollution. Prospects for reducing the use of groundwater and restoring its services to ecosystems look remote unless alternative management approaches are developed.

## 1.3 Global Water Resources Distribution

Global water resources are estimated at about 1.36 x $10^{18}m^3$. A large portion of these (96.5%) are made up of salt water mainly in the oceans, while only about 2.5% is available as freshwater. Out of this 2.5% of fresh water, 1.3% is available as surface water and 30.1% as groundwater, while the remaining 68.6% is locked up as glaciers and ice caps. Figure 3 shows the distribution of global water resources.

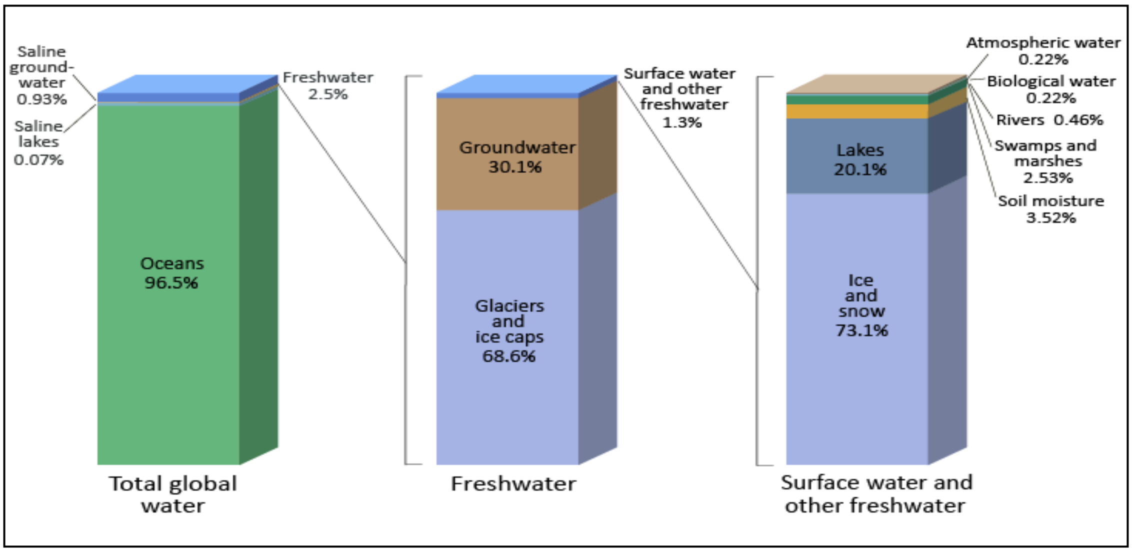


**Figure 3: Distribution of Global water resources**
**(Source: Shiklomanov, 1993)**

Initially, surface and ground water were studied separately and represented different resource development opportunities. Recent experience has shown the need for integration of the two, especially within the IWRM concept.

Thus, sustainable management of water resources should take into account the natural water balance that determines the amount of water resources and its availability in time and space as well as consideration of inter-linked systems such as ecological, economic and social which have been largely ignored in the past.

## 1.4 Water Resources in Africa

Water resources in Africa are made up of both surface and groundwater. Table 1 shows the important rivers in Africa and their characteristics.

**Table 1 : Major Rivers in Africa and their features**

| River | Source of Effluent | Length (km) | Basin Area ($10^3$ $km^2$) | Transboundary Coverage |
|---|---|---|---|---|
| Congo | Chambeshi-Luapula, Lomami, Lulonga, Ruki, and Kasai Rivers and lake Tanganyika | 4,700 | 3,699.1 | Democratic Republic of Congo, Zambia, Angola, Burundi, Cameroon, Central African Republic, Republic of Congo, Rwanda and Tanzania |
| Nile | Lake Victoria | 6,850 | 3,110 | Burundi, Rwanda, Tanzania, Uganda, Kenya, Sudan, Ethiopia, Egypt, Eritrea and DR Congo, |
| Niger | Bani River in Mali, Kaduna and Benue Rivers in Nigeria | 4,200 | 2,274 | Benin, Burkina Faso, Chad, Cote d'Ivoire, Guinea, Mali, Niger, Sierra Leone and Nigeria |
| Zambezi | Luena, Lungue, Bongo, Kafue, Luangwa and Shire Rivers | 2,700 | 1,388.2 | Zambia, Angola, Zimbabwe, Namibia, Mozambique, Malawi and Tanzania |

There are both natural and man-made lakes in Africa which are ranked among the largest in the world. These include Lake Victoria (second largest freshwater lake in the world), Lake Tanganyika, (second deepest in the world about) and Lake Chad (shallowest major lake). Table 2 gives the names of major lakes in Africa and their characteristics.

Table 2: Major Lakes in Africa and their characteristics

| Lake | Area ($km^2$) | Maximum Depth (m) |
|---|---|---|
| Victoria | 68,800 | 84 |
| Tanganyika | 32,000 | 1,471 |
| Malawi | 30,900 | 706 |
| Chad* | 18,000 | 11 |
| Turkana | 8,660 | 73 |
| Lake Albert (formerly Mobutu Sese Seko ) | 5,300 | 58 |

*Lake area varies due to seasonality of precipitation

**(Source: Shiklomanov and Roda, 2003)**

Other major lakes in Africa are Lake Edward (previously known as Lake Idi Amin), Lake Kivu, Lake Naivasha, Lake Natron and Lake Eyasi. In addition, there are man-made impoundments often described as dams or artificial lakes which store huge amount of water resources such as Lake Volta in Ghana, Lake Nasser in Egypt, Aswan dam, and Kainji dam in Nigeria. Africa's natural and artificial lakes have combined capacity in terms of volume that is twenty times that of Latin America (Wallings 1996).

Groundwater is another important source of freshwater in Africa, supplementing surface water resources, representing 15% of Africa's renewable water.

Just as there are shared river basins, there are also shared or transboundary groundwater resources and aquifer systems hidden underground in Africa. Table 3 gives an outline of some of the major transboundary aquifer systems in Africa containing huge groundwater resources.

**Table 3: Some Major Transboundary Aquifer Systems in Africa**

| Aquifer System | Shared Countries | Extension ($km^2$) | Exploitable Reserves ($km^3$) |
|---|---|---|---|
| Nubian Sandstone | Egypt, Libya, Sudan and Chad | 2,200,000 | 6,500 |
| North Western Sahara | Algeria, Libya and Tunisia | 1,000,000 | 1,280 |
| Murzuk Basin | Algeria, Libya and Niger | 450,000 | 60 - 80 |
| Maastrichtian | Mauritania, Senegal and Gambia | 200,000 | 480 - 580 |
| Iullemenden Multilayer Continental | Mali, Niger and Nigeria | 500,000 | 250 - 2,000 |
| Chad Basin | Niger, Nigeria, Chad, Sudan, Cameroon and Libya | 600,000 | 170 - 350 |
| Central Kalahari / Karroo Sandstone | Botswana, Namibia and South Africa | 80,000 | 86 |

**(Source: Foster and Loucks, 2006)**

## 1.5 Water Resources Challenges

Water is a "finite resource" and all the water components in the hydrological cycle form part of one large cycle. Thus, any intervention by man or nature, at or on one part of the cycle has an impact on another part of the cycle. For instance, the diversion of surface water may reduce recharge of groundwater, and excessive extraction of groundwater has the potential of reducing base flow to rivers or streams. Water quality is also important to the dynamics of ecology with its interrelated natural systems such as land and forests (Sharma *et al*., 1996).

Pressures on water resources are most often related to human development and economic growth. There are abundant examples of how water has contributed to economic development and how development has increased demand for consumption and use of water resources. Such benefits came at a cost and lead to increasing pressure on the environment and competition among users. For example, about 40% of the world's food requirement is estimated to depend on irrigation. Agriculture uses more water than any other area of human activity, absorbing around two-thirds of freshwater withdrawals from rivers, lakes and aquifers (UNEP, 2004).

With increasing population in Africa, the continent is likely to face tough water resources challenges due to increasing demand and competition for freshwater for human consumption, industrial and agricultural production and generation of hydropower. Not only does this impose conflicts over water flow volumes between different users but also creates problems for downstream users from pollution, with far reaching implications for livelihoods, ecology and public health. Consequently, the provision of water for societal and environmental needs in Africa will no doubt become a major challenge toward achieving sustainable development and management of water resources. Some of the key factors affecting management of water resources in Africa are:

a). Hydrological:

- spatial and temporal variability (especially precipitation)
- recurring and prolonged droughts
- increasing desertification

b). Socio-economic:

- high and rapid growing population
- increasing urbanisation
- increasing poverty
- inefficient agricultural/irrigation practices
- decreasing and poor industrial practices

c). Environmental:

- poor and fragmented watershed management
- water pollution & destruction of aquatic habitats
- excessive and uncontrolled groundwater exploitation
- poor environmental sanitation and hygiene practices

d). Institutional:

- fragmented management (role definition)

- inadequate coordination (horizontally/vertically)
- policy inconsistency
- inadequate stakeholder participation
- insufficient hydro-meteorological information

e). Financial:

- Irrational pricing policies for raw/treated water
- Non-collection of pollution charges
- Lack of transparency and accountability
- inadequate financing for watershed protection
- inadequate financing for data management

f). Transboundary Waters:

- upstream versus downstream of shared river systems
- weak efforts and growing concern about Regional Basin Management Commissions

Water is recognized to be essential for achieving sustainable development and the Millennium Development Goals. However, due to the above factors, a number of African countries still face huge challenges in attempting to achieve the UN's water and sanitation related Millennium Development Goals (MDGs).

# 2.0 INTRODUCTION TO INTEGRATED WATER RESOURCES MANAGEMENT (IWRM)

**Learning Objectives:**

At the end of this module, trainees are expected to be able to:

- Understand the meaning and principles of IWRM;
- Link IWRM to hydrological cycle and water resources functions and appreciate its relevance for managing conflicts;
- Understand basic processes for implementing IWRM at river basin level.

## 2.1 What is IWRM?

Several definitions of IWRM abound in literature however the Global Water Partnership's definition is most widely accepted. This is given below in Box 2.

**BOX 1: Definition of IWRM**

> IWRM is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (GWP, 2000).

The above definition places IWRM beyond being simply the management of water quantity and quality but rather a philosophy to achieve sustainable use of water resources by all stakeholders at catchments, regional, national and international levels, while maintaining the characteristics and integrity of the resource within agreed-upon limits.

## 2.2 Concept of IWRM

Competition for water and inability to meet the needs of society and environment call for enhanced societal responses through improved management, better legislation and more effective and transparent allocation mechanisms. This demands an integrated approach to water resources management that takes into account social, economic and environmental goals as well as the achievement of sustainable development.

The emergence of IWRM concept is a result of the search for a new water management framework due to increasing water resource challenges highlighted above. Different ideas and principles were placed in a framework together with goals of economic efficiency, social equity and sustainability of ecosystems. This resulted in a new paradigm for integrated water resources management – the IWRM. The concept has been accepted widely by water managers, decision-makers and politicians around the world.

The consensus that provided understanding and guidance for decision-makers and practitioners alike to come up with this holistic approach to water resources management is expressed in the key principles (see Box 3) articulated at International Conference on Water and Environment, January 1992 in Dublin. The Dublin Principles formed the basis of Agenda 21 (see Box 3) of the United Nations Conference on Environment and Development in Rio de Janeiro in 1992.

**Box 2: Dublin Principles and Agenda 21 focus areas of action**

**Dublin Principles**

- Freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment;
- Water development and management should be based on a participatory approach involving users, planners and policy makers at all levels;
- Women play a central part in the provision, management and safeguarding of water;
- Water has an economic value in all its competing uses and should be recognized as an economic good.

**Agenda 21**

- Ensure the integrated management and development of water resources;
- Assess water quality, supply and demand;
- Protect water resources quality and aquatic ecosystems;
- Improve drinking water supply and sanitation;
- Ensure sustainable water supply and use for cities;
- Manage water resources for sustainable food production and development;
- Assess the impact of climate change on water resources.

## 2.3 Links between Hydrological Cycle and IWRM

To link the hydrological cycle to the principles of IWRM, it is important to review the basic principles of IWRM.

Key IWRM principles address the following:

- Water source and catchments conservation are essential;
- Water allocation should be agreed upon between stakeholders;
- Management needs to be taken care of at the lowest appropriate level;
- Capacity building is the key to sustainability;
- Involvement of all stakeholders is required;
- Efficient water use is essential and often an important "source" in itself;
- Water should be treated as having an economic as well as a social value;
- A gender balance is essential.

The notion that freshwater is a finite resource is often seen in the hydrological cycle as an average yield of fixed quantity over a time period. However, the hydrological cycle is continuously affected by the modification of the landscape due to land and water use. Understanding the linkages between the land use and the hydrological cycle is important for improved water management. The manner in which both quantity and quality of waters within a basin are available and influence ecosystem relationships is complex.

Consequently water resources management needs to be coordinated with other disciplines and sectors that affect water resources. IWRM strives for effective and reliable delivery of water services by coordinating and balancing the various water-using sectors. This is also an important part of sustainable water management and conflict transformation (Figure 4).

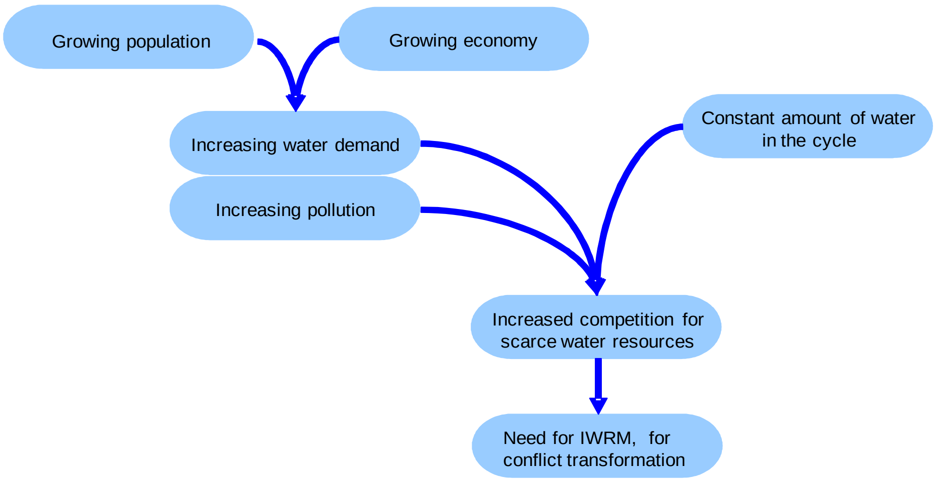


**Figure 4: IWRM for Conflict Transformation**

## 2.4 Water Resources Functions and IWRM

Water resources perform a wide variety of functions that deliver goods and services for the society and sustenance of ecosystems. Some of the functions are:

- Environmental functions: recharging groundwater and river systems, augmentation of dry season flow, assimilation of wastes;
- Ecological functions: providing soil moisture for vegetation, providing habitat for aquatic animals and plants, supporting wildlife and biodiversity;
- Socio-economic functions: supply of water for domestic use, agriculture, industry and power generation, facilitating navigation and recreation.

IWRM takes into account not only the financial and economic costs and benefits of water management decisions, but also the social and environmental costs. Ignoring these functions in water management decisions can have large impacts on economies, the environment and livelihoods.

Therefore, IWRM promotes:

- A shift from a sectoral to a more cross-sectoral approach which integrates ecological, economic and social goals in order to achieve multiple and cross-cutting benefits;
- The coordinated management of water, land and related resources;
- Integration of use, integration of demand, integration with the environment as well as integration with the people;
- Stakeholder participation to encourage wider ownership and to empower stakeholders. Active involvement of all affected and interested groups in resolving

conflict and promoting general sustainability to bring more resource efficient and socially responsible water management that benefits all sections of society will involve new institutional arrangements; and

- A systems approach that recognizes the individual components as well as the linkages between them, and that a disturbance at one point in the system will be translated to other parts of the system.

## 2.5 Implementing IWRM at River Basin Level

Implementing the IWRM process enables integration of downstream and upstream issues, quantity and quality, surface water and groundwater, and land use and water resources in a practical manner. IWRM is a step-by-step process that takes time and requires getting ‘three pillars’ to be put in place which are summarized below and shown in Figure 5.

- moving towards an enabling environment of appropriate policies, strategies and legislation for sustainable water resources development and management;
- putting in place the institutional framework through which the policies, strategies and legislation can be implemented;
- setting up the management instruments required by these institutions to do their job.

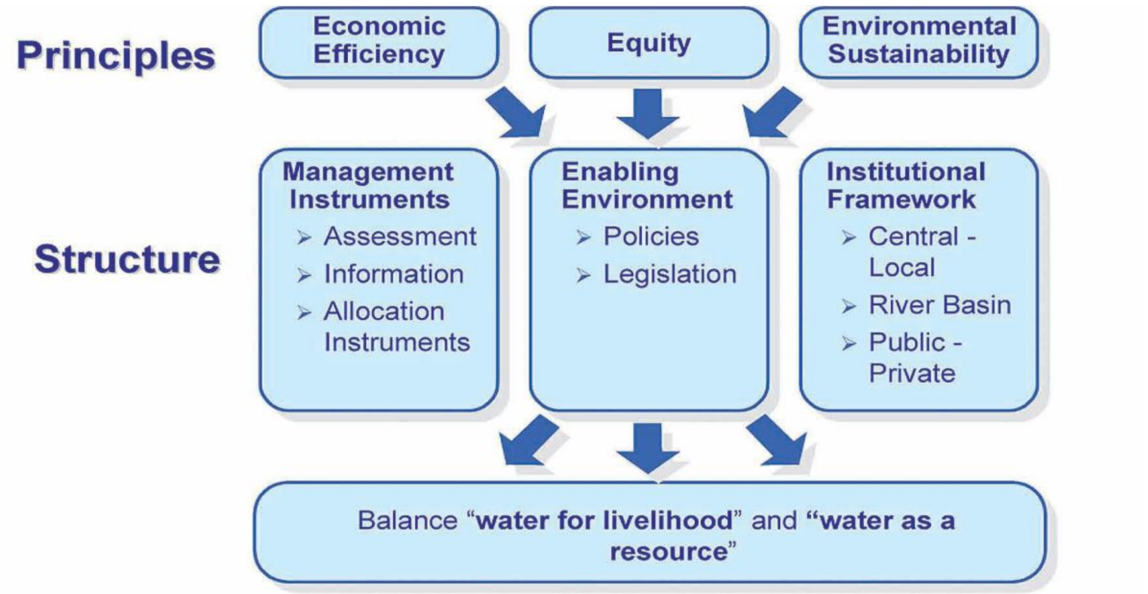


**Figure 5: The three pillars of IWRM**

**(UNESCO, 2009b)**

IWRM requires platforms to be developed that will allow different stakeholders to work together. However, due to existing institutional and legislative frameworks, implementing IWRM principles is likely to require reforms at all stages in a countries' water planning and management cycles. A comprehensive plan is required to envisage how the transformation can be achieved and this is likely to begin with a new water policy to reflect the principles of sustainable management of water resources. It may also require reforming existing water laws and water institutions. This can be a long process and often requires extensive consultations with affected institutions and the public.

**EXERCISE**

**Title:** Understanding the need for IWRM

**Purpose:** To share experience on the need for IWRM

**Materials:** marker and flip chart/cardboard paper

**Procedure:**

i) Participants to be in groups (preferably each group should comprise of participants from the same location, region or country);

ii) Each group to brainstorm and answer the following questions:
   - What are the three major water resources management issues in your locality, region or country?
   - How are they being addressed?
   - Is there need to manage water resources in an integrated manner in your locality, region or country?
   - What will be the benefit for the different stakeholders?
   - How are men and women affected by the water resources management in your locality, region or country?

iii) Each group to make presentation in plenary.

# 3.0 UNDERSTANDING CONFLICT AND DISPUTES OVER WATER RESOURCES

**Learning Objectives:**

At the end of this module, trainees are expected to be able to:

- Grasp the meaning of conflict and terms relating to conflict;
- Understand the nature and causes of conflicts over water resources as a starting point for its management;
- Understand the different kinds of conflict and stages of their development.

## 3.1 Introduction

Conflict is a social situation in which two or more actors pursue incompatible goals or objectives. The presence of conflicts can have negative impacts the country's economic development. Conflict is defined in the Box 4 below.

**Box 3: Meaning of Conflict**

| |
|---|
| Conflict is a process that begins when an individual or group perceives differences and opposition between oneself and another individual or group about interests and resources, beliefs, values or practices that matter to them. This process view can be applied to all kinds of parties – nations, organizations, groups, or individuals – and to all kinds of conflict – from latent tensions to manifest violence (NOSR, 2007). |

## 3.2 Conflict and Development

Development is a conscious process of change intended to improve the overall well-being of a population. However, change often creates social and political dislocations, which may put development at risk. Thus, development interventions do not always equate to peace, and the choices sometimes made by individuals, communities and nations can generate conflicts and/or deepen existing ones. Consequently, sustainable development must be founded on the principles of social justice and inclusiveness if it is to promote peace and well-being.

Conflicts can be resource-based, political, social, religious, identity or ethnic, but the root cause is often linked to a specific context and stage of development. In the context of water resources, conflicts are often resource based and arise due to increasing pressures from a number of actors, forces and factors on a limited resource. Given the diversity of needs and interests that surround water resources, disputes and conflicts over the resource are frequent. In addition, water resources development processes, access, allocation mechanisms and management often challenge the existing socio-economic, political and cultural equations in ways that can threaten, or inhibit the aspirations of some individuals, groups or communities. However, the ability to respond constructively to perceived threats or hindrances determine if such conflicts will enhance or jeopardise peace.

## 3.3 Some Basic Terms Relating to Conflict

### 3.3.1 Conflict Setting

Conflict setting is the environment within which conflict occurs. It is also referred to as the 'context.' It includes the geo-physical and psycho-social environment in which the conflict occurs.

### 3.3.2 Conflict Dynamics

Conflict dynamics are the activities and events in the political, economic and socio-cultural domains which result from and are shaped by the conflict context.

### 3.3.3 Conflict Actors

Conflict actors are individuals, groups or institutions which are directly or indirectly involved with a conflict.

### 3.3.4 Conflict Analysis

Conflict analysis is the study of the profile of a conflict, its root causes, actors and dynamics. The profile of a conflict includes the history, political economic and socio-cultural elements involved in the conflict. The understanding gained from conflict analysis informs the response strategies for intervention.

## 3.4 Nature of Disputes over Water Resources

Water resource conflicts may take many forms that range from mild disagreement to threats and acts of physical violence. The typology of conflicts over water resource are broadly classified under the following headings:

- Water governance crisis;
- Transboundary issues;
- Competing uses;
- Upstream – downstream effects.

### 3.4.1 Water Governance Crisis

Water governance establishes the way in which water is managed (see Box 5 for a definition of water governance). It determines how, or whether, water resources are managed sustainably. However, sectoral approaches and lack of holistic perspective regarding water have led to fragmented and confused systems of water management causing conflicts between sectors. Water sector institutions generally function independently and rarely operate in coordination with each other. This leads to fragmented and uncoordinated sector development and management of the resource. Furthermore, water management tends to become influenced by sectoral interests whose priorities are elsewhere. This is particularly the case where large economic interests in sectors such as mining, tourism, forestry, industry, water services, and hydropower are involved. The Bakolori Irrigation Dam Project is a typical case study where government did not accommodate the interests of the farming communities that were displaced. This led to a social crisis – protest, rebellion and death of farmers (see **Case Study 3.1 p.287**).Thus, poor water governance results in increased competition for the finite resource and less resilient livelihoods and economic growth (WWAP, 2003).

**Box 4: Description of Water Governance**

Water governance refers to the political, social, economic, legal and administrative systems that develop and manage water resources and water services delivery at different levels of society while recognizing the role played by environmental services (Tropp, 2007).

There are characteristics in the water sector which make it vulnerable to unethical practices that can be potential sources of conflicts. Typical examples are large water monopolies, falsified meter readings, distorted site selection of boreholes or abstraction points for irrigation, collusion and favoritism in the allocation of water for commercial irrigation, and cover up of water pollution and wastewater discharges to prevent public protest over resource contamination.

### 3.4.2 Transboundary Issues

It is estimated that over half of the world's freshwater flows in catchment areas, or basins of rivers, lakes and aquifers that cross national borders (WWAP, 2003). Africa alone has 63 shared water basins, and the water resources of a number of major rivers and aquifer systems emerging from these basins are shared between two or more countries. Thus, when a river or aquifer runs through a national boundary separating countries, there is always competition between users which can lead to conflicts. For example water sharing between countries through which run major rivers like the Congo, Nile, Niger and Zambezi is evidently an important political and strategic issue for the countries concerned. The Lake Chad Basin is bordered by many countries and experiences conflicts due to multiple user demands as illustrated in **Case Study 3.2 (p.288).** While there is a need for key players involved in management of transboundary waters to work towards cooperation potential; in fact at the international level, water appears to provide reasons for transboundary cooperation rather than conflict.

### 3.4.3 Competing Uses

The uneven distribution of water resources and human activity are fundamental sources of water resources crises in many parts of the world. Conflicts on water can occur at all levels. The most common conflict is within agricultural systems particularly irrigation, where farmers live with often limited available water resources. Conflicts also occur between agriculture and other uses. Some of the competing water needs causing conflicts are between domestic and agricultural uses, agriculture and industry, agriculture and fisheries, domestic and recreation uses and rural and urban areas. Conflicts are both economic (e.g expected return from volume of water use differs greatly across these uses) and political (e.g social importance and influence of each sector). For example, while agriculture gets by far the largest share of diverted water resources and also consumes the most water for crop production, water is also used for drinking and other domestic purposes for the fast growing world population. This is especially the case for urban populations. Shifting main water consumption from agriculture to other uses with higher economic value is frequently proposed as an alternative; however it is accepted that future global food supplies cannot be secured without intensification of agriculture and irrigation. Another inter-sectoral conflict which is of major concern is between hydropower and other sectors, especially agriculture, fisheries and ecosystems. Because the energy production of hydropower plants follows consumer demand, the dams may release water when downstream irrigators do not need it (or during flooding). Dams also harm fisheries by impeding fish migration and reducing productivity by altering the water regime. The perceived economic value of water in non-agricultural sectors is often higher than for agriculture. Thus, competition among uses and users is increasing in almost every country, calling for more effective negotiation and allocation mechanisms.

### 3.4.4 Upstream – downstream Effects

Demand for water is often at the highest when availability is at the lowest, and conflicts tend to increase accordingly. Water resources are increasingly diverted, controlled and used as countries develop. Water flowing out of sub-basins is often committed to upstream uses without consideration to downstream users. Degradations in the quality of surface water upstream due to combined discharge of effluents from residential areas, industries, agricultural activities and sediments have far reaching impacts on people's livelihood and public health downstream.

Instances exist where projects designed to meet national objectives ignore their impacts on the river basin as a whole and neglect the potentially conflicting needs of downstream users, especially with artificial impoundments and dams. According to WWAP (2009), dams, through their impacts on flood-pulse regimes, have altered complex ecosystems that were providing valuable services and supporting livelihoods (such as fisheries, agriculture, pastures, and medicinal plants) due to river discharges falling short of requirements. Typical cases occurred in the Senegal Valley and the Hadejia-Jama'are plains in northern Nigeria.

The need for a conflict resolution mechanism can be summarised in Figure 6.

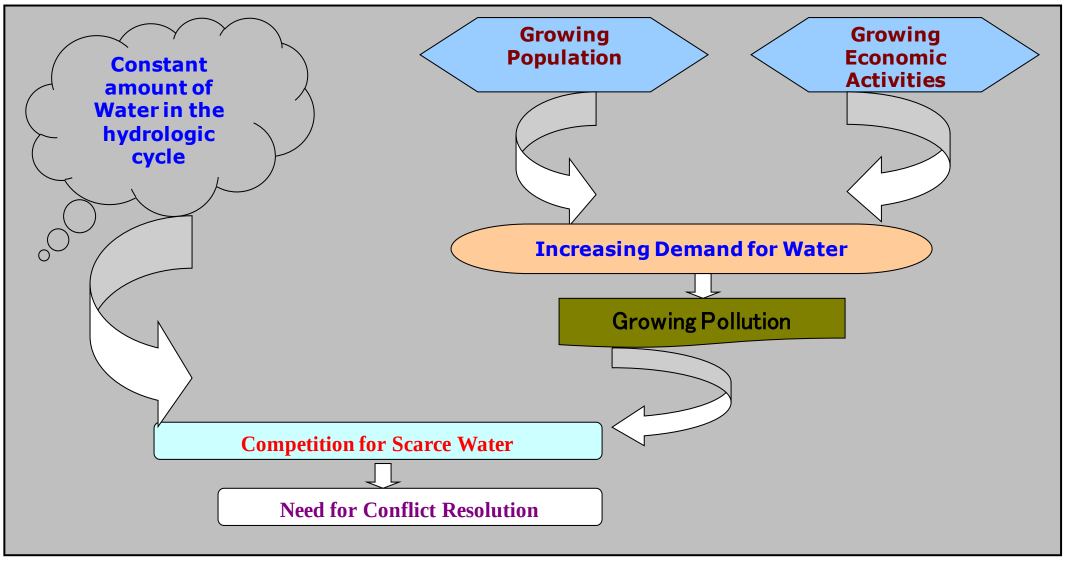


**Figure 6 : Water Resources Challenges and Need for Conflict Resolution**

## 3.5 Types of Conflict and Stages of Development

Conflicts can be classified into four types as follows (Cap Net, 2008b:26):

- Intra-personal – conflict that occurs within ourselves e.g flash of cognitive dissonance;
- Inter-personal – conflict that occurs between two or more people e.g disagreement, argument etc;
- Intra-group – conflict that occurs within one group e.g rivalry or contestation, opinions etc; and
- Inter-group – conflict that occurs between two or more groups e.g discrepancy in held views etc.

Conflict between two or more actors can develop through four major stages which are outlined as follows:

### 3.5.1 Latent Stage:

This is the first stage when the existing differences are not strong enough to impinge on the actors involved. Little, or sometime nothing could be done to resolve conflict at this stage because, the actors involved may deny that there is a problem. However, conflict at this stage either resolves itself naturally or escalates.

### 3.5.2 Recognized Stage:

At this stage, the actors involved can no longer deny that there is a problem. It may become so obvious to the extent that the actors cannot deny what is happening, and sometimes can hamper peaceful co-existence. At this level, attention should be focused on the conflict rather than the actors involved. Conflict should be resolved at this stage and in fact, should not be allowed to develop beyond this stage in the interest of cohesiveness of the individuals or group involved.

### 3.5.3 Polarization Stage:

Conflict at this stage has escalated, involving individuals or an entire group with some actors taking sides while others withdraw. The actors may be divided into factions with increased cohesion on each side. Every side protects its interests thus leading to selective perception, and considering issues from their own perspective only. Generally, there is overt animosity towards each other.

### 3.5.4 Manifest Stage:

At this stage, behaviours and attitudes change from passive to open aggression, competition of arguments and isolation from each other. The actors display distrust among members. While damaging comments are being made about each other, a satisfaction is derived in the destruction of the other. All these result in open confrontation and violence while peaceful co-existence is completely forgotten.

**EXERCISE**

**Title:** The E W 3 M Chart

**Purpose:** To highlight how individuals in a group can view things differently due to differences in perception

**Materials:** Cardboard paper/flip chart with W boldly written on it

**Time:** 20 minutes

**Procedure:**

i) Four volunteers or nominated persons required;

ii) Spread a card board with W boldly written on it on the ground;

iii) Each person stands on each side of the card;

iv) Each person to read out what he/she has seen;

v) Four different responses will come out, and each should be recorded accordingly;

vi) Let the people standing convince each other on what each has seen. Allow them to argue and agree on one letter because only one letter/figure is on the card;

vii) Ask all the four to stand on one side and tell what is on the card.

**CASE STUDY 3.1**

**The Bakolori Irrigation Project**
Bakolori irrigation scheme lies within semi-arid northern Sudan Savannah zone of Nigeria. It was established to cope with the problems of aridity, rainfall variability, and famine.

Dam Characteristics
- Area of 8000 hectares 19km upstream from the dam;
- Dam is 5.5 km long earth fill structure (360m long and 48m high) concrete central section;
- Storage capacity of 450million $m^3$;

Before Dam Construction
- Underdeveloped Northern Nigeria;
- National needs and interest including foreign interests;
- Farmers needs not considered;
- Downstream impact not considered;
- 50,000 people made their living as floodplain farmers within 2-10km wide and 120km long floodplain downstream;
- Local farmers grow rice and sorghum (wet season) and vegetable crops (dry season).

After Dam Construction
- Evaporation losses from reservoir;
- Dam altered pattern of the natural runoff of the Sokoto River;
- Dam partly closed and released;
- Agriculture and fisheries affected;
- Out of 35,000 hectares only 23,000 hectares developed.

Social Crisis at Bakolori:
- Resettle 2,866 families;
- Land expropriation was made with inadequate compensation;
- During 3 years of implementation of the irrigation scheme, farmers on site were not allowed to cultivate;
- Demand compensation over loss of land, homes and economically valuable trees;
- Lacked democratic Institutions to articulate their interest;
- Peaceful demonstration to rebellion;
- Attempt to stop construction;
- Anarchy and disruptive result.

Government's Response
- Compensation issues delayed;
- Identifying the rightful owners of the land;
- Finally deployed riot-police and 386 protesting farmers were killed.

**CASE STUDY 3.2**

**Lake Chad Basin**

- Basin constitute the largest fresh water resources in the Sahelian region of Africa;
- Shared by a population of about 20,036,000 people;
- The conventional basin approx. 967,000 $km^2$;

Management Initiative

- Lake Chad Basin Commission (LCBC) in 1964 (Nigeria, Niger, Chad and Cameroon);
- Lake Chad Research Institute established;
- Lake Chad basin Authority established;
- Launched the International Campaign to save Lake Chad Basin at 8th Summit of Heads of State and Government of LCBC at Abuja in March 1994;
- Contributed equally the sum of 312,884,000 FCFA needed for the job. (Territories of Cameroon, Niger, Nigeria and Chad in Lake Chad);
- Inter-basin transfer options study $6million.

Major Challenges

- Water resources allocation (large irrigated areas and different ecosystems) e.g Semry in Cameroon, Sodelac in Chad, Nigeria South Chad irrigation scheme;
- Formation of spirals of Degradation;
- Over-exploitation of halieutic stocks fishing and over exploitation of aquifers through indiscriminate use of motor pumps by farmers;
- Threat to environment;
- Persistent drought, desertification and poor management of water resources by member countries;
- Aquifer depletion and low water table and deterioration of water quantity and quality;
- Drastic reduction in size and content 25,000$km^2$ in 1964 to about 3,000$km^2$ by 2006;
- Decline in biodiversity and increase vulnerability to erosion and poverty;
- Large dams upstream without due regards to ecosystems downstream and end users;
- Inadequate system for monitoring the quantity and quality of water, early warning system and preservation measures;
- Lack of active commitment by members;
- Capacity of the basin to provide sustainable means of livelihood for 20 million people;
- Use of chemicals for fishing.

Socio-economic Issues

- Poverty;
- Inadequate Information sharing;
- Inadequate stakeholder participation;
- Population growth;
- Urbanization;
- Prohibitive costs of operation and maintenance give rise to abandonment of large scale irrigation schemes;
- Increase pressure on the dwindling resources of the basin.

Sources/Areas of conflicts

- Socio-economic problems + drought desertification results into conflicts;
- Increase potentials of conflicts, farmers versus Pastoralists, member states etc;
- Increase competition between production activities leading to conflicts. Stock breeders/farmers, fishermen/farmers;
- Land and water degradation trends and changes in the Lake Chad ecosystems;
- Intra-state conflicts (Kano,Borono, Jigawa, Yobe, and Bauchi;
- Reduce flows;
- Severe drought and desertification a war broke out between Nigeria and Chad over emerging Islands in 1983;
- Border demarcation exercise approved by Heads of States of the LCBC at their 6th Summit held in N'Djamena on 28th and 29th October 1987.

# 4.0 CONFLICT HANDLING APPROACHES

**Learning Objectives:**

At the end of this module, trainees are expected to be able to:

- Distinguish between conflict management and conflict resolution;
- Understand the different methods for conflict resolution and ways of preventing conflict;
- Learn techniques for conflict resolution;
- Understand essential skills needed for managing conflict.

## 4.1 Introduction

The social losses attributable to conflict, especially in developing nations like those in Africa, call for development theorists and practitioners to focus on understanding the mutual interface between conflict, peace and development. This awareness has recognized the need for promoting conflict resolution or conflict management mechanisms. The idea is for development planners and implementers to be proactively engaged with conflicts that arise or would arise in the context of development. For this reason, clarity between approaches used for handling conflicts need to be clearly outlined for the understanding of planners and professionals alike.

## 4.2 Conflict Management and Conflict Resolution

According to Cap-Net (2008b), there are two aspects of conflict handling. The first is “Conflict Management” which has emerged with a much broader approach. The second is the more conventional “Conflict Resolution” method. While “conflict resolution” methods concentrate on using techniques after the occurrence of a conflict, “conflict management” assumes a more pro-active role in preventing conflicts by fostering productive communication and collaboration among diverse interests, addressing the underlying causes of conflicts, developing trust and understanding and using participatory and collaborative planning for undertaking complex tasks.

**4.2.1 A conflict management** approach uses methods that involve negotiation, mediation, pacification and consensus building. It involves the use of a combination of array of tools to anticipate, prevent and react to conflicts. These tools are used to persuade actors to open up, identify the real issues, and find “win-win” solutions that leave both actors better off with the outcome. Thus, this kind of approach fits well in the planning stage of a project or programme of water resource development anticipating possible sources of conflict. It is a continuous process in which stakeholders constantly work to create conditions that discourage dysfunctional conflict and facilitate "win-win" outcomes.

**4.2.2 Resolution of conflict or disputes** is usually associated with legal outcomes where aggrieved actors turn to the law in search of a 'once and for all' approach that too often leads to win-lose outcomes and a settlement that leaves one party frustrated, disappointed and perhaps in search of revenge. Since we all need water, these approaches are to be avoided. In place of formal legal approaches, there exist Alternative Dispute Resolution (ADR) mechanisms. These are based on principle of negotiation – i.e. the desire to bargain in good faith toward mutually-beneficial, win-win outcomes for long-term gain.

## 4.3 Understanding Conflict Resolution Methods

Conflict resolution, is conceptualized as the methods and processes involved in facilitating the peaceful ending of conflict. The term conflict resolution may also be used interchangeably with dispute resolution. It is based on intuition, logic and communication skills. Parties often attempt to resolve conflicts by actively communicating information about their conflicting motives, interest or ideologies to each other. The following are the most common methods of conflict resolution.

### 4.3.1 Litigation

Litigation is the use of the courts and civil justice system to resolve conflicts. It involves a formal judicial proceeding allowing full examination and determination of all the issues between the parties with each side presenting its case to either a jury or a judge. The decision is made by applying the facts of the case to the applicable law in the area of jurisdiction. In some cases ligation is often regarded as the last resort when differences cannot be resolved through Alternative Dispute Resolution (ADR) processes (negotiation, mediation, arbitration or some other means)

### 4.3.2 Alternative Dispute Resolution (ADR)

ADR processes are methodologies for resolving dispute outside of court litigation. They are not a substitute for litigation but are complimentary. ADR is a vital component of justice delivery in any conflict resolution process. Its characteristics include flexibility, privacy, non-biased and voluntary approaches. ADR techniques are acceptable within many traditional societies. The techniques involved include:

#### 4.3.2.1 Negotiation

Negotiation is often the first method of choice for resolving dispute and trying to reach a mutually acceptable agreement. It involves two-way communication between the parties about the conflict with the goal of trying to find a solution. This entails direct discussion between the parties for solving their differences. Basically the strategies adopted in negotiation may be either competitive (win-lose) or problem solving (win-win). Representatives of interested parties are invited to participate in negotiations to agree on new rules governing issues such as water rates.

#### 4.3.2.2 Facilitation

Facilitation is a process in which the parties to a conflict, with the help of a neutral third party (Facilitator), identify problems to be solved, tasks to be accomplished or disputed issues to be resolved. The facilitator may assist the parties to develop options, consider alternatives and try to reach an agreement. It is used in situations involving multiple parties, stakeholders, and where issues are unclear. Facilitators create an enabling environment where everybody is able to speak freely. However, facilitators are not expected to volunteer their own ideas or participate actively in moving the parties towards agreement.

#### 4.3.2.3 Mediation

Mediation is an informal method of dispute resolution where a neutral third party called the mediator assists parties to a conflict in finding a solution to their disagreement through a mediation process. Mediation often is the next step if negotiation proves unsuccessful. A mediator does not make a decision nor force an agreement. The parties directly participate and are responsible for negotiating their own settlement or agreement.

The attributes of Mediation are promoting effective communication and cooperation, ability to resolve disputes voluntary, flexibility, confidentiality, allowing parties to make mutually acceptable agreements tailored to meet their needs, avoiding the uncertainty, time, cost and stress of going to trial and preserving on-going relationships.

#### 4.3.2.4 Arbitration

Arbitration is typically an out-of-court method for resolving a dispute. It is the submission of a disputed matter to an impartial person (the arbitrator) for resolution. The arbitrator controls the process, listens to both sides and makes a decision. Like a trial, only one side will prevail. Unlike a trial, appeal rights are limited.

Arbitration is characterized by the following:

- It can be adapted voluntarily and privately;
- It is less formal and structured than going to court;
- It is an opportunity to present evidences and make arguments;
- It is an opportunity to choose an arbitrator with specialized expertise;
- Decisions of an arbitration can often be enforced in a court.

### 4.3.3 Comparison of Methods of Resolving Conflicts

The comparisons between different methods of conflict resolution techniques are presented in Figure 7. It shows that resolving conflict through ADR approaches (negotiation, mediation etc.) is likely to result in preventing the conflict and preserving on-going relationships. Therefore as one move towards the left hand side of the chart, better gains for the actors is likely to be realised and conflict avoidance increases. While resolving conflict through third party system, as in the case for arbitration and litigation, is likely to result in increased coercion and likelihood of win-lose situation. Thus, as you move towards the right side of the chart, violence and directive action is experienced with settlement that leaves one party disappointed and resentful.

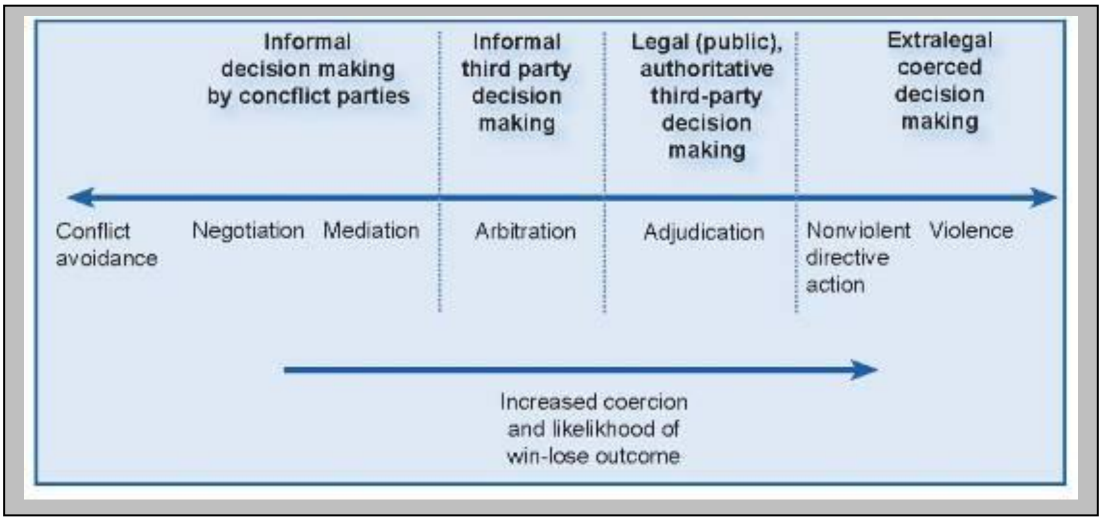


**Figure 7: Comparison of Methods of Conflict Handling**

**(Source: Cap-Net, 2008b)**

### 4.3.4 Basic Requirements for ADR Processes

The following factors are critical for conflicts resolution as outlined by Cap Net (2008b).

#### 4.3.4.1 Willingness

Parties involved in a conflict must be free and willing to participate, and where necessary, withdraw from a conflict resolution process when not satisfied. They should set the agenda and decide on the method to be followed in the process. It is, however, impossible even to agree to discuss a problem if either of the parties holds deeply entrenched positions or system of values.

#### 4.3.4.2 Mutual Gain

A major factor to the success of conflict resolution is the expectation that the contending parties will be better off through cooperative action. If any of the parties, or both, believe that they can achieve a better outcome through unilateral action, they will not be willing to participate in the process.

#### 4.3.4.3 Participation

It is important that parties to a conflict must be given opportunity to participate in the conflict prevention process, otherwise it is unlikely to be successful. Exclusion of an interested party is not only unfair but is also risky for the reason that such parties may obstruct the implementation of the outcome by either legal or extra-legal means.

#### 4.3.4.4 Interest

Parties to a conflict often engage in positional bargaining without listening to the interests of each other. This creates confrontation and a barrier for reaching an agreement. Thus, identifying common interests rather than positions is critical towards reaching an agreement and possibly resolving the conflict.

#### 4.3.4.5 Opportunity for Alternatives

The neutral development of possible solutions and options under ADR presents alternatives to conflicting parties to make a choice. This provision is particularly important as it gives an opportunity to the parties whether or not they would be bound by the terms of the settlement.

#### 4.3.4.6 Respect for Agreement

Although ADR has potential to lead to mutual satisfaction of parties interests however the parties themselves must also be capable of entering into, carrying out and respecting an agreement.

### 4.3.5 Ways of Preventing Conflict

#### 4.3.5.1 Creating Enabling Environment for Stakeholder Participation

When there is need for decision making on water resources development and/or management issue(s), there may be different interests and opinions at stake. This may lead to prolong arguments and disagreements which may consequently result in conflict. Thus, for a conflict to be prevented or resolved, it is crucial that people understand how to manage or prevent their occurrence. Conflicts can be anticipated and avoided through the creation of spaces such as fora where stakeholders can meet and communicate their positions, needs and interests. Table 4 provides some potential sources of conflicts and examples on ways of preventing them.

**Table 4: Potential sources of Conflict and ways of preventing them**

| Potential Sources of Conflict | Conflict Prevention |
|---|---|
| The issue or situation that requires a decision is too vague and not clear to all people involved | Ensure that clarity exists among all involved |
| Not all people are convinced that a decision is required | Check whether all people involved are convinced about the need for change |
| A general lack of communication and information; not all concerned are invited and/or only a few people get the chance to voice their ideas | Make sure that all stakeholders are present and give everybody a chance to speak out. It may be useful to spilt in small groups |
| Hasty decision-making; without looking at all options properly | Note down all possible options and weigh them before a final decision is taken |
| Lack of clarity about decision making method | Ensure that everyone involved understands and agrees on the decision making method |
| Animosity among members in the group that need to take the decision | Ensure that the animosity is discussed openly |

#### 4.3.5.2 IWRM as Mechanism for Conflict Prevention

The basis for IWRM implies that all the different uses of water resources are to be considered together, taking into account the wide range of people's water needs. Water allocations and management decisions should consider the effects of each type of use on the others, and take into account overall social, economic and environmental goals. IWRM recognizes multiple water users, conflicting needs and increasing demand.

Therefore, IWRM takes into account not only the integration of technical, social and political aspects of water resources system, but also acts as a tool for conflict prevention and potentially one for conflict resolution with ADR inside the larger framework of the IWRM concept.

## 4.4 Strategy for Conflict Resolution

A conflict resolution process requires that the mediator/facilitator should:

- Carry out conflict analysis – This exercise involves stakeholder assessment (further described below), identifying root causes of the conflict and relations among actors, physical mapping of the location of the conflict, etc.

- Interface outcome of the conflict analysis with situation analysis to understand the dynamics of the conflict – Building a complete picture of the physical, social and psychological layout of the conflict;

- Plan and implement peace building variables to resolve the dispute – The intervention should be designed to address the root causes of the conflict, ensure fairness, justice and inclusion;

- Monitoring agreement – When actors mutually accept an agreement, the mediator/facilitator assists them to determine how compliance with the terms of the agreement will be monitored (possibly involving the mediator/facilitator).

In this context, a stakeholder is a person or a group of people who have a direct interest in the conflict. The purpose of a stakeholder assessment is to identify the various actors who are involved in and those that might have potential influence on the conflict. It enables to understand the relationships among actors and possibly links to the cause of the conflict. Involving actors in the analysis of the problem that affects them and in the design of potential solutions is a good way to achieve sustainable dispute resolution. It is useful to prepare a list or matrix of all the actors or groups concerned showing in which way they are affected or involved in the conflict.

The nature of conflict gives a hint about the type of information to be collected and analyzed. Knowing the exact root causes of the conflict is essential to arrive at a useful and durable solution that addresses the real issue. Looking for sustainable solutions to a conflict requires thorough analysis of the issues identified and their inter-connected relationships. A problem tree can help to visualize the cause-effect relationships in a diagram. The following steps may guide in building a problem tree:

- STEP 1: Identify major issues existing within the stated problem situation (brain storming);

- STEP 2: Write up short statement of the core problem;

- STEP 3: Write up the cause(s) of the core problem

- STEP 4: Write up the effect caused by the core problem;

- STEP 5: Form a diagram showing the cause and effect relationships in the form of a diagram known as “Problem Tree”;

- STEP 6: Review the diagram as a whole and verify its validity and completeness.

Once the inter-relation between issues is clear, it is often easy to see which solution will have more impact. This is achieved by building an “Objective Tree”. This is built by restating all negative conditions of the problem tree into positive conditions that are desirable and realistically achievable.

The more complete the analysis, the more likely it is that the mediator/facilitator will be able to help actors uncover a productive pathway to sustainable dispute resolution and to develop long-term conflict management plan.

## 4.5 Essential Skills for Handling Conflicts

### 4.5.1 Negotiation

Negotiation is a usual characteristic of life experience and can be soft or hard. The soft negotiator wants to avoid personal conflict and so makes concessions readily in order to reach agreement. The hard negotiator sees any situation as a contest of wills in which the side that takes the more extreme positions and holds out longer fares better. Other standard negotiating strategies fall between hard and soft, but each involves an attempted trade-off between getting what you want and getting along with people.

A good negotiation technique should be judged by three criteria:

1. It should produce a wise (mutually acceptable) decision or agreement (where agreement is possible);
2. It should be efficient; and
3. It should improve or at least not worsen the relationship between the actors.

A wise decision or agreement is one that meets the legitimate interests of each side to the extent possible, resolves conflicting interests fairly, is durable, and takes actors' interests into account (Fisher et al, 1991).

The third way to negotiate, neither hard nor soft, but rather a combination of both, is called principled negotiation and was developed in the Harvard Negotiation Project (Fisher et al, 1991). It decides issues on their merits rather than through discussion focused on what each side says it will and won't do (see Table 5).

**Table 5Comparison of Negotiation Approaches**

| SOFT | HARD | PRINCIPLED |
|---|---|---|
| PARTICIPANTS ARE FRIENDS | PARTICIPANTS ARE ADVERSARIES | PARTICIPANTS ARE PROBLEM-SOLVERS |
| THE GOAL IS AGREEMENT | THE GOAL IS VICTORY | THE GOAL IS A WISE OUTCOME REACHED EFFICIENTLY AND AMICABLY |
| MAKE CONCESSIONS TO CULTIVATE THE | DEMAND CONCESSIONS AS A CONDITION OF THE | SEPARATE THE PEOPLE FROM THE PROBLEM |

| | | |
|---|---|---|
| RELATIONSHIP | RELATIONSHIP | |
| BE SOFT ON THE PEOPLE AND THE PROBLEM | BE HARD ON THE PROBLEM AND THE PEOPLE | BE SOFT ON THE PEOPLE, HARD ON THE PROBLEM |
| TRUST OTHERS | DISTRUST OTHERS | PROCEED INDEPENDENT OF TRUST |
| CHANGE YOUR POSITION EASILY | DIG IN TO YOUR POSITION | FOCUS ON INTERESTS, NOT POSITIONS |
| MAKE OFFERS | MAKE THREATS | EXPLORE INTERESTS |
| DISCLOSE YOUR BOTTOM LINE. | MISLEAD AS TO YOUR BOTTOM LINE | AVOID HAVING A BOTTOM LINE |
| ACCEPT ONE-SIDED LOSSES TO REACH AGREEMENT | DEMAND ONE-SIDED GAINS AS THE PRICE OF AGREEMENT | INVENT OPTIONS FOR MUTUAL GAIN |
| SEARCH FOR THE SINGLE ANSWER: THE ONE THEY WILL ACCEPT | SEARCH FOR THE SINGLE ANSWER: THE ONE YOU WILL ACCEPT | DEVELOP MULTIPLE OPTIONS TO CHOOSE FROM: DECIDE LATER |
| INSIST ON AGREEMENT | INSIST ON YOUR POSITION | INSIST ON USING OBJECTIVE CRITERIA |
| TRY TO AVOID A CONTEST OF WILL | TRY TO WIN A CONTEST OF WILL | TRY TO REACH A RESULT BASED ON STANDARDS INDEPENDENT OF WILL |
| YIELD TO PRESSURE | APPLY PRESSURE | REASON AND BE OPEN TO REASON: YIELD TO PRINCIPLE, NOT PRESSURE |

Under principled negotiation, problems are resolved through analysis of the issues. Principled negotiation or negotiation on merits comprised four basic characteristics. Each characteristic deals with a basic element of the negotiation, and suggests what should be done with it as follows:

1. People: Separate the people from the problem;
2. Interests: Focus on interests, not positions;
3. Options: Generate a variety of possibilities before deciding what to do;
4. Criteria: Insist that the result be based on some objective standard.

Therefore, a good negotiator has a special responsibility to ensure that the group is fully committed to the decisions taken.

Negotiation related to the IWRM context inevitably involves different types of stakeholders such as direct and indirect, powerful, powerless, marginalized and acknowledged ones. Therefore in such a setting of unequal capacities and power arrangements, principled negotiation is often a key mechanism towards sustainable solution. However, if power disparities are very pronounced, principled negotiation may be difficult or next to impossible. In this case, it is more likely that facilitation or mediation may be more effective.

### 4.5.2 Mediation

This is a voluntary process in which an impartial person (the mediator) helps with communication and promotes resolution between the parties which will allow them to reach a mutually acceptable agreement. The mediator looks for alternatives based on the facts and merits of the case.

According to Cap-Net (2008b), an effective mediator should have most of the following characteristics:

- Ability to create trust;
- Ability to define issues at the heart of the dispute;
- Patience, endurance, perseverance;
- Thoughtfulness, empathy, flexibility;
- Common sense, rationality;
- Often a likeable personality;
- Accurately perceived as having much experience; and
- Neutrality, impartiality, problem-solving skills, creativity, reflexivity.

Mediation styles can vary from active and intervening to rather passive. In any event, to be effective a mediator must:

- Be willing and able to call on expert knowledge and/or use decision-support tools;
- Meet with aggrieved parties jointly and separately; and
- Elicit ideas from both sides.

An effective mediator focuses on the future without forgetting the past. A good mediator must first remember to do no harm. He/she should also be sensitive to the possibility of a spoiler in the setting. That is, one or more actors determined to obstruct any progress toward a negotiated outcome. At the same time, the mediator should look for connectors – those people and issues that may draw parties to a grievance toward each other and toward a successfully negotiated outcome. Mediation is more formal than facilitation and is used when there is some relationship existing among actors, even if there are hostilities.

### 4.5.3 Facilitation

Facilitation is an art that promotes dialogue, openness and problem solving by learning from each other or a group. The role of a facilitator is to provide a process which will help a group to discuss their own content in the most satisfactory and productive way possible. As a facilitator, you can influence discussions by how you present information, what kind of atmosphere you set for the parties, and your attitudes towards them. A good facilitator:

- should be neutral;
- have good communication skills; and
- will not judge, criticize or push his/her own ideas.

As outlined by Cap-Net (2008b), the tasks of a facilitator are as follows:

- Assists in meeting design;
- Helps keep meeting on track;
- Clarifies and accepts communication from parties to the negotiation;
- Accepts and acknowledges feelings;
- Frames a problem in a constructive way;
- Suggests procedures for achieving agreement;
- Summarizes and clarifies direction;
- Engages in consensus-testing at appropriate points; and
- Promote an atmosphere of co-operation.

The facilitator needs to understand the different forces operating in a group. He/she needs to enable the group to understand the problem and deal with it constructively. However, facilitation works best in low to medium level conflicts.

**ACTIVITY 4.1**

**Title:** The problem tree
**Purpose:** To understand the use problem tree in problem analysis
**Materials:** marker and cardboard paper/flip chart
**Time:** 30 minutes
**Procedure:**

i) Participants to be in groups;
ii) Each group to carefully study activity 3 and develop a problem tree;
iii) Each group to also developed an objective tree in order to address the causes of the core problem;
iv) Make presentation in plenary.

**ACTIVITY 4.2**

**Title:** My Corner
**Purpose:** To highlight how a group can have conflicting interest due to differences in individual objectives and goals
**Materials:** marker and cardboard paper/flip chart
**Time:** 20 minute
**Procedure:**

i) Participants to form four groups
ii) Each group to nominate one person to represent the group
iii) Ask the nominated persons to form a circle holding hands
iv) Ask everyone to choose part of the room as theirs but not tell anyone
v) Each person should visits his/her corner without breaking the circle in the process

**Questions:**

a) How many people reached their corners?
b) Why could no one reach his/her corner?
c) What could have made it possible for each person to reach his or corner?
d) Each group to identify and discussion how to resolve the problem and keeping in mind the following:
    - Reaching an agreement and not damaging the basic cooperation among the individuals involved;
    - Its outcomes or agreements should be more favourable and most desirable for improving the effectiveness of the group;
e) Make presentation in plenary.

# 5.0 COMMUNITY INVOLVEMENT IN RIVER BASIN MANAGEMENT

**Learning Objectives:**

At the end of this module, trainees are expected to be able to:

- Grasp basic concepts of community participation;
- Understand the benefits and levels of community involvement in river basin management;
- Understand the strategies for integrating community in river basin management;
- Understand how to form community management structures and maintain their active participation in river basin management.

## 5.1 Introduction

Participatory management is based on the idea that people can share their perceptions of a problem, offer their opinions and ideas, and have the opportunity to make decisions. The principle underlying participatory management is to give people a voice and a choice. Thus community involvement in the management of water resources on which they depend is one of the building blocks of the concept of IWRM. Involving community in the development and management of water resources enables them to:

- Analyze their needs;
- Identify possible solution to meet those needs; and
- Develop, implement and evaluate a plan of action.

Community involvement offers a broader view, guarantees ownership by water users and the acceptance of decisions. It has become obvious that water resources policy can no longer be limited to technical interventions, but increasingly needs to be implemented through people and their participation. Thus, the institutional framework for water resources management should enable active participation of communities and integrate all stakeholders at all levels.

## 5.2 Community Involvement in River Basin Management

There are several benefits that can be derived from involving communities in water resources management. Some of them are highlighted below:

- It leads to informed decision-making as communities do possess a wealth of information which can benefit water resources management;

- Communities are the most affected by lack of water resources or poor management decisions on water resources and therefore can help prioritize actions for basin management;

- Reaching consensus with communities at early stages of projects development can reduce the likelihood of conflicts which can hinder successful implementation of such projects;

- Community involvement can build trust between the government and civil society which can possibly lead to long-term collaborative relationships.

Stakeholder participation is particularly important to prevent conflict situations. Future conflicts can be anticipated by creating participative mechanisms through an enabling environment in which various basin's actors that have different interests or needs can meet, discuss and participate in the decision making process regarding their basin.

An example is the case of Komadugu-Yobe Basin (KYB) in Nigeria presented as **Case Study 5.1 (p.316).**

## 5.3 Types of Community Involvement

Community involvement in river basin management is a process which takes varying forms. This can be categorized into four types which may coexist. These comprise information sharing, consultation, decision making and initiating action.

### 5.3.1 Information Sharing

This represents the simplest form of community involvement. In this case a community participates by being informed what has been decided or has already happened. Information sharing should not be confused with participation. Passing information through meetings to communities for example about new government policies is necessary but it is not the same as participation of people. Information sharing enhances communities' understanding of specific issues.

### 5.3.2 Consultation

These are instances where communities participate by being consulted or by answering questions. In this situation, communities are only informed and their opinions sought on key issues, but with no obligation to take on board their views. Socioeconomic surveys, beneficiary assessments, and willingness - to - pay studies are some examples of consultations.

### 5.3.3 Decision Making

Participation is often seen as a means to achieve project goals in a sustainable way. Participation in decision making or functional participation can apply to project design, maintenance strategy at different stages etc. In this case a community may participate by forming groups to meet pre-determined project objectives. Involving a community in decision making promotes empowerment.

### 5.3.4 Initiating Action

Communities own a cumulative body of knowledge and know-how that can be essential for the success of a water project. Initiating action or interactive participation, present the highest form of community involvement. In this case, a community participates in joint analysis, which leads to action plans and the formation or strengthening of local groups or institutions that determine how available resources are to be used.

The most appropriate level of participation depends on who takes decision and initiates action on basin management. Table 6 and 7 present a comparative analysis of participation approaches.

**Table 6Extent of Community Participation**

| Nature of participation | Degree of participation | | |
|---|---|---|---|
| | Nominal | Partial | Full |
| 1. Getting information | ▲ | | |
| 2. Giving opinion | ▲ | | |
| 3. Advising | ▲ | | |
| 4. Participating in providing information | ▲ | | |
| 5. Periodical functional relations | ▲ | | |
| 6. Long term functional relations | | ▲ | |
| 7. Establishing organizations with external initiative | | ▲ | |
| 8. Participatory decision making | | ▲ | |
| 9. Being organized at own initiative | | | ▲ |
| 10. Establishing the majority peoples' control and leadership in project planning and implementation | | | ▲ |

Table 7: Comparison of Passive and Active Community Participation

| Passive Participation | Active Participation |
|---|---|
| Problems are not analyzed properly with community | Problems are analyzed with community |
| Needs of community are not determined but brushed over | Needs of community are determined and a plan is based on their felt needs |
| Decision is made by outsider and communities are merely informed | Decision is made by people concerned |
| Resources come from outside the community and development depends on availability of the resources | Community mobilize and utilize locally available resources |
| Community is not involved in management | Community leads the management process. |
| Quick implementation | Time-consuming process |
| Monitoring and evaluation is conducted by community by outsider | Monitoring and evaluation is conducted by community. |

| Passive Participation | Active Participation |
|---|---|
| No ownership<br><br>Local resource is not mobilized<br><br>No sustainability<br><br>No participation of community | Ownership is enhanced and guaranteed.<br><br>Local resource can be identified and mobilized<br><br>Sustainability in ensured<br><br>Participation of community is enhanced |

## 5.4 Strategy for Integrating Community in River Basin Management

For a River Basin Organization (RBO) to carry out effective water resources management functions of river basin planning, water allocation, pollution control and monitoring effectively, it requires a participatory approach. Therefore, an RBO needs to create a stakeholder participation process in the river basin. This process involves identification, mobilization, organization and capacity building of stakeholders in order to maintain their involvement over time. Furthermore, different parts of water resources management may require different ways of stakeholder involvement.

### 5.4.1 Identification of Stakeholders

The first step for an RBO to organize its operations is to identify and group the stakeholders in its river basin. A stakeholder is a person or group of people who have direct interest in the project because of its existence will materially affect their lives (EC, 1998).

The identification of stakeholders through stakeholders' analysis helps select who to involve in the river basin management. The right selection of stakeholders needs to follow criteria such as the following:

- Who are the potential beneficiaries from water management decisions?
- Who are those that live near the river basin?
- Who are those that are powerful and have influence in the area?
- Who are the vulnerable groups who might be adversely impacted?
- Who are the supporters and opponents of change to water management systems?
- Who are those that have formal role in the area or river basin management?
- Who are those that might facilitate policy improvement?
- Are gender interests adequately identified and represented?
- What are the relationships among the stakeholders?

In addition to the above, the following may need to be considered:

1. List all organizations that might be important (Government agencies, NGOs, companies, schools/colleges/research institutes/universities);
2. Classify stakeholders on the basis of your criteria. A matrix can be used to rank all the stakeholders based on how important they might be to the river basin. One common way to categorize stakeholders is as follows:

- *Water users* – those who need water for use such as farming communities, utilities, industries, hydropower);
- *Governmental institutions* – those according to their public service role have a stake or influence in water management in the river basin (e.g agriculture, environment, health);
- *Civil society* – those that may assist to create awareness or facilitate policy improvement (e.g Non-Governmental Organizations).

3. Plan how and when to involve people and organizations. However, not all stakeholders may have participatory relationship with the river basin. It may be necessary to involve certain "weak" groups to help them to strengthen their position or build their capacity. Some stakeholders may not want to participate because they are afraid that it will harm their interests.

### 5.4.2 Community Mobilization

Community mobilization deals with ways of creating awareness and stimulating interest of community members to obtain their buy-in. Mobilization may be achieved through information sharing, visits to community, participating in community meetings or by bringing community representatives to a specific meeting. A common way of mobilizing a community is to invite them to workshops in which more information is provided, and in which problems or other situations with respect to water resources management in the sub-basins are heard and discussed. Figure 8 shows a sample of some steps to follow during mobilization.

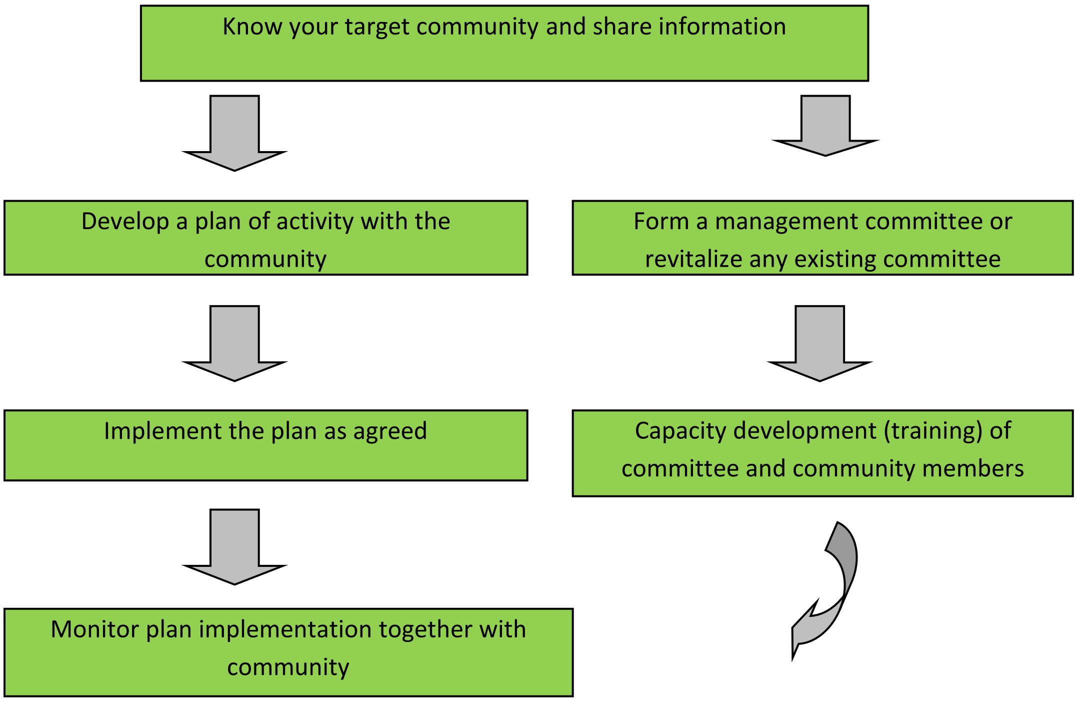


**Figure 8: Sample of Steps to follow during Mobilization Process**

Thus, when a community is adequately mobilized, people's perceptions, attitudes and behaviour changes are identified so that the following can be achieved:

- Empowerment and capacity development of community organizations and community members
- Sustainable management through functional operation and maintenance system
- Expanded and efficient service delivery by using local resources (human resources, natural resources, financial resources and so on), and
- Ultimately, the community gains confidence in themselves and are easily motivated to carry out new projects and activities independently.

**5.4.2.1 Understanding the Target Community**

When carrying out community mobilization you must first identify and understand your target community. Information generated should be jointly analyzed together with community members. Apart from meetings, several participatory tools may be used to facilitate mobilization process such community mapping, transect walks, Venn diagrams, gender analysis, wealth classification, problem analysis.

**5.4.2.2 Planning**

When adequate information about the community is obtained, such as problems and needs of different socio-economic groups and available local resources, the participatory tools can be used to create understanding and initiate action on basin management related issues such as water availability and use, maintenance status, structural changes, gender issues, or other constraints. Next, a plan to address issues of concern must be developed and actions agreed upon with community members. Appropriate actions must be selected by community members based on their needs and capacity so that community members can be aware of their responsibilities, and obligations. Table 8 presents a typical format of a plan of activity.

Below are useful questions that could be utilized when making plan with communities:

- What is the core problem?
- What is your goal?
- What need to be done (what activity) to achieve the goal?
- What are the available resources we have?
- When do we need to do it?

- Who will do it?
- What are the measurable indicators?
- What is/are the output?

**Table 8: Typical Community Plan of Activity**

| Selected Solution | Activities to Implement | Resources Needed | Responsibility | Timeline |
|---|---|---|---|---|
| Repair of lined canal | Sealing of cracks and raising of canal height | Cement, sand, sluice gates | Farmers | immediately |
| Enhance extension activities | Purchase of vehicles and motorcycles,<br><br>Increase budgetary allocation | Vehicles, motorcycles and spare parts | RBO | On-going project |
| Diversify high value crops | Land preparation, watering, planting, spraying, harvesting, storage and marketing | Seed variety, fruit seedling, nursery, chemicals, manure and extension service | Farmers | On-going project |

In mobilizing a community the following needs should be recognised and considered in order to develop mutual trust:

- Acceptance;
- Sharing information and concerns;
- Setting goals;
- Organizing for action.

#### 5.4.2.1 Acceptance

People, like plants, need the right kind of enabling environment to grow. The facilitator has a special role and responsibility to develop such a, environment. Community people need to be assured that they are truly accepted and they are safe to say what they really think and feel. Thus the uniqueness of each person, with his/her own experience and insights, needs to be recognized. Unless there is a spirit of respect and acceptance, community people will not be free to learn, rethink their old opinions and share fully their thoughts and feelings.

#### 5.4.2.2 Sharing Information and Concerns

When working with communities, there is need to promote a two-way flow of information, especially about:

- The community, their experiences, ideas, values, and opinions;
- The issues which they consider to be more important to their lives.

Information from the facilitator must be relevant to the community. The facilitator should share his/her concerns and information after community members have shared theirs, and it should be offered for discussion, and not imposed.

#### 5.4.2.3 Setting Goals on Basin Management

Unless goals are set by the community, they will not be interested in or committed to carrying them out. The goals need to be clear to all and decision made collectively to prevent or minimize frustration.

#### 5.4.2.4 Organizing for Action

Once goals have been set, the community needs to make definite plans to achieve these goals and carry out decisions. This requires a structure which is appropriate for the community, encourages responsibility and accountability, and which will ensure that one person will not assume all the responsibility or control all the actions.

### 5.4.3 The Need for Community Management Structures

Participation does not mean involving everyone in every activity or decision. Although the significance of traditional management structures and local leadership is often acknowledged, the general trend is that water resources management systems require new forms of local organization to manage them. Thus, there is a need to have some kind of structure or management body to represent the participating community, since a community as a whole cannot represent itself. This is particularly important as a formal community structure (community representative body) makes the work for an RBO much easier, limiting the need for continued community mobilization and ensuring a formal and regular link to the community. For large river basins there is a practical need for introducing sub-basin committees or a similar structure. Each of these sub-committees may have a number of representatives in the main river basin committee. Similarly, communities belonging to a certain sector may have a branch organization (e.g. water user associations, farmers unions etc.) that is represented in the sub-basin or basin committees. Typical water committees' set-ups and links with government bodies are shown in Figure 8.

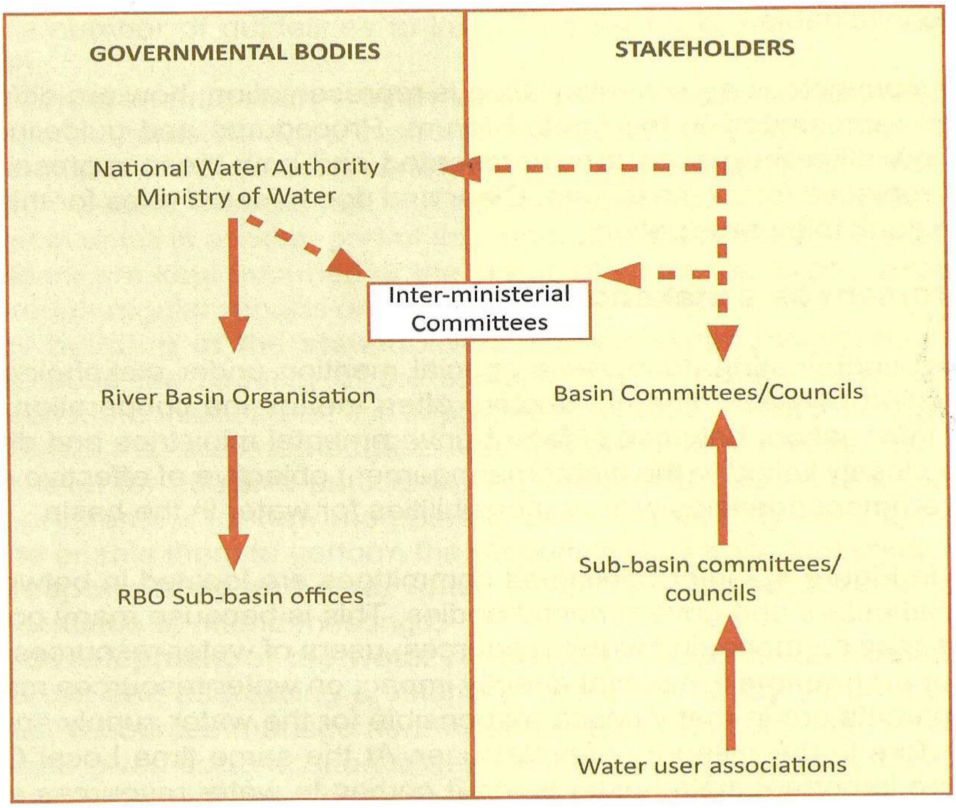


**Figure 9: Typical Water Committees Set-up and Links with Government Bodies**

**(Source: Cap-Net, 2008a)**

An essential issue with water committees is how different groups or sub-committees are represented in a central forum. Procedures and guidelines must be clarified on how different groups or sub-committees are represented and how these representatives are selected and replaced from time to time. Clear and documented rules for this are important to obtain equitable participation. In addition, it is also important to clarify on the roles and responsibilities of the water committees in the water resources management process. An example of possible stakeholder roles in water resources management is shown in Table 9.

**Table 9 Possible Stakeholder Role in Water Resources Management**

| Water Management Function | Possible Stakeholder Roles |
|---|---|
| Basin planning | Problem identification, priority setting, situation analysis |
| Water Allocation | Advisory, monitoring and reporting, decision making |
| Pollution control | Monitoring, reporting, regulating |

**(Source: Cap-Net, 2008a)**

### 5.4.4 Formation of Community Water Committees

The formation of community water committees is best done democratically by the communities themselves, however many communities lack a democratic model of electing representation and find it difficult to adjust to such demands. The RBO can provide guidance by the following:

- Knowing the local community;
- Adequate sensitization and mobilization on the subject;
- Enlightenment, dialogue and information dissemination;
- Meetings;
- Guiding communities to make their selections;
- Election of members (agency staff can witness the election as observers only);
- Swearing in of elected members.

#### 5.4.4.1 Selection Criteria

The selection criteria for the water committee members should include, but not be limited to, the following:

- Resident of the local community;
- Leadership quality;
- Inclined to serve the community;
- Preferably women from the user community should be encouraged;
- Willing to undergo training;
- Having quality that is essential to a particular position (e.g ability to read and write).

### 5.4.5 Community Decision Making and Conflict Prevention

A good understanding of how decisions can be made by communities and assumptions of problems that may occur in the decision making process can help prevent conflict. Decision making methods include the following:

- By majority: Can be done quickly, but only in case of decisions that do not have a very big impact.

- By drawing lots: Can be done quickly and everybody has an equal chance to win. However, can only be used in case of decisions that do not have a very big impact.

- By consensus: results from open communication and listening to each other's ideas and to conflicting opinions. It is a process of give-and-take which leads to all group members being more willing to adhere to the decision, even though it does not fully reflect their own ideas. Reaching a consensus may require some compromise by group members and can be time consuming, but usually leads to sustainable decisions.

- By delegation (for example to a water committee): Some people are authorized to take the decisions, which may lead to quick decisions. However, the delegation needs to be representative and to have people who are knowledgeable and committed to the cause rather than powerful.

- By authority: The decision is made by a formal or informal leader. The decision may be made too fast for others to understand what is happening. Power conflicts may also arise and this may not necessarily be in the interest of the majority, the poor or the most vulnerable.

**5.4.6 Maintaining Active Community Involvement**

One of the biggest challenges of participatory water resources management is for an RBO to maintain active participation of the local community and different stakeholders in the river basin. Below are a number of guidelines for promoting active participation:

**5.4.6.1 Information Dissemination**

Information is important to keep up communities' interest for water resources management and to create a sense of local ownership of the process. A variety of information tools may be used (meetings, workshops, pamphlets, visits and consultations). The idea is to ensure that communities are kept informed of the status of water resources management in the basin.

**5.4.6.2 Collective Ownership of the System**

The RBO in collaboration with the communities take ownership and attendant obligations of the system such as:

- Participating in project planning and implementation;

- Participating in Operation and Maintenance (O & M);

- Deciding on technology options;

- Making decisions regarding the system.

### 5.4.6.3 Collective Control of the System

The RBO in collaboration with the community decides on:

- Service level;
- Formation of local organization;
- Usage regulations;
- Determination and collection of water charges;
- Technology choice.

### 5.4.6.4 Capacity Building

Community involvement is sometimes hampered because the capacity of the communities is too low to allow for effective participation. For this reason, the RBO should have a regular capacity building programme for community members and all the relevant stakeholders to enhance their knowledge and skills to enable them perform any new role required of them.

### 5.4.6.5 Providing Services

The RBO should serve as a knowledge and resource hub for the stakeholders providing information and extension services. These may include river flow and rainfall statistics, soil type, agricultural planning or cropping patterns.

**CASE STUDY 5.1**

**The Komadugu-Yobe Basin (KYB), Nigeria**

- Inter-state and transboundary basin in Northern Nigeria;
- Drains a catchment area of approximately 84,000 km2 before discharging into Lake Chad;
- Politically, it covers six northern states in Nigeria and the Diffa and Zinder regions in southern Niger Republic;
- Supports over 15 million people through agriculture, fishing, livestock keeping and water supply;
- The two major rivers in the basin are Hadejia and Jama'are, which meet to form the Yobe;
- Major features in the basin are; the two large dams, the Kano river irrigation project, the Hadejia valley irrigation project and the Hadejia-Nguru wetlands.

Problems in the KYB

- Increasing population and urbanisation;
- Increasing water demands (water demands in the basin exceed available water by 2.6 times);
- Rapid environmental deterioration- due to failed water management institutions;
- Manifesting into:
  - channel blockage and desiccation in some places; excessive all-year flooding in others
  - aquatic weed infestation
  - potash encrustation
  - inundation of major roads, settlements, farm & grazing lands
  - general increase in poverty levels
  - conflict over access to natural resources

Collective Decision Making

- Since early 1990s stakeholders have individually or collectively come together in various forms and composition to attempt to address the water issues in the basin. Particularly upstream versus downstream conflicts
- The Stakeholder Consultative Forum (SCF) comprising of over 60 members across the basin has reached consensus on a number of issues pertaining to the problems of the basin and have proposed corrective measures for addressing them.
- Government ministries, agencies and CBOs in each State and across all six riparian states on the KYB which hitherto work in virtual isolation have now started consultation and working together on common water related issues through harmonized work plans of the State Integrated Water Resources Committee (SIWRMCs).
- The KYB Wetlands Development Initiative (KYB-WDI) comprising over 400 community representatives uses this committee as a platform for discussing problems affecting resources management (along river channels) in the KYB as well as engage in physical interventions such as communal channel clearance work.
- The KYB Technical Advisory committee (TAC) is a body set up by the FMWR to serve as a platform for a participatory approach to the management of water resources in the KYB, a basic necessity for the process of IWRM
- The KYB Trust fund provides a means of pooling resources, technical as well as financial, from various sources to facilitate and maximise the impact of planned interventions in the basin.

**ACTIVITY 5.1**

**Title:** Venn diagram

**Purpose:** To enable participants view and describe important institutions within and around their organizations or in their sector and how they inter-relate with each other

**Materials:** marker and cardboard paper/flip chart

**Time:** 1 hour

**Procedure:**

i) Participants to be in groups (preferably those from the same organization should be the same group);
ii) Each group to mention any formal and informal groups/institutions in and around their organizational setting or sector;
iii) Each group to identify what these groups/institutions do and the degree of relationships between them in terms of decision-making and operational responsibilities;
iv) Each group to write the name of each group/institution in a circle, making sure that only one circle contains one name;
v) Each group to arrange the circles in such a way that the degree of contact/overlap between the circles dictates the relationship in terms of decision-making and/or operation. Overlap occurs if one institution/group asks or tells another to do something or if they have to cooperate in some way to carry out their responsibilities or because their responsibilities are partly the same etc;
vi) The arrangements of the circles should be as follows:
    - The size of the circle should reflect the importance of the institution/group
    - Separate circles means no contact
    - Touching circles means that information passes between the institutions
    - Small overlap means that some cooperation in decision making and operation exists and
    - Large overlap means that considerable cooperation in decision making and operation exists
vii) Groups to make presentation in plenary and explain their drawing, levels of existing cooperation and also where cooperation is lacking;
viii) Participants to explain what they have learned from the activity.

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European Commission
**EUR** 26622 – **Joint Research Centre – Institute for Environment and Sustainability**

Title: NEPAD Western African Water Centres of Excellence - Water Resources and River Basin Management Joint Training Course
Editors: Biedler M., Donin G., Leone A., Carmona Moreno C.

Luxembourg: Publications Office of the European Union

2014 – 319 pp. – 21.0 x 29.7 cm

EUR – Scientific and Technical Research series – ISSN 1018-5593 (print) ISNN 1831-9424 (online)

ISBN 978-92-79-37914-7 (print)
ISBN 978-92-79-37913-0 (pdf)

Doi: 10.2788/63102 (online)

**Abstract**
**Within the framework of the EC support project to the AU-NEPAD Water Centres of Excellence one the project's tasks was to improve water sector knowledge development and management in the region; consequently the CoEs were requested to develop relevant educational material in the form of academic training courses. Within the Western African Network, the exercise of producing training material was based on earlier consultations and studies from a stakeholder analysis and a skills and trainings needs assessment study. The result was a short list of training priorities, which finally resulted in the development of 5 Master's degree-level courses, namely: Gestion integrée des ressources en eau; Water allocation and demand management; Post-construction monitoring and evaluation, Environmental Impact Assessment, Conflict Resolution in River Basin Management.**

LB-NA-26622-EN-N

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ISBN 978-92-79-37913-0