FAO/AgWA | OMVS

Tasks and responsibilities within the Project

Dakar, 24-25 January 2017

Working together to achieve a better integrated cross-boundary water management

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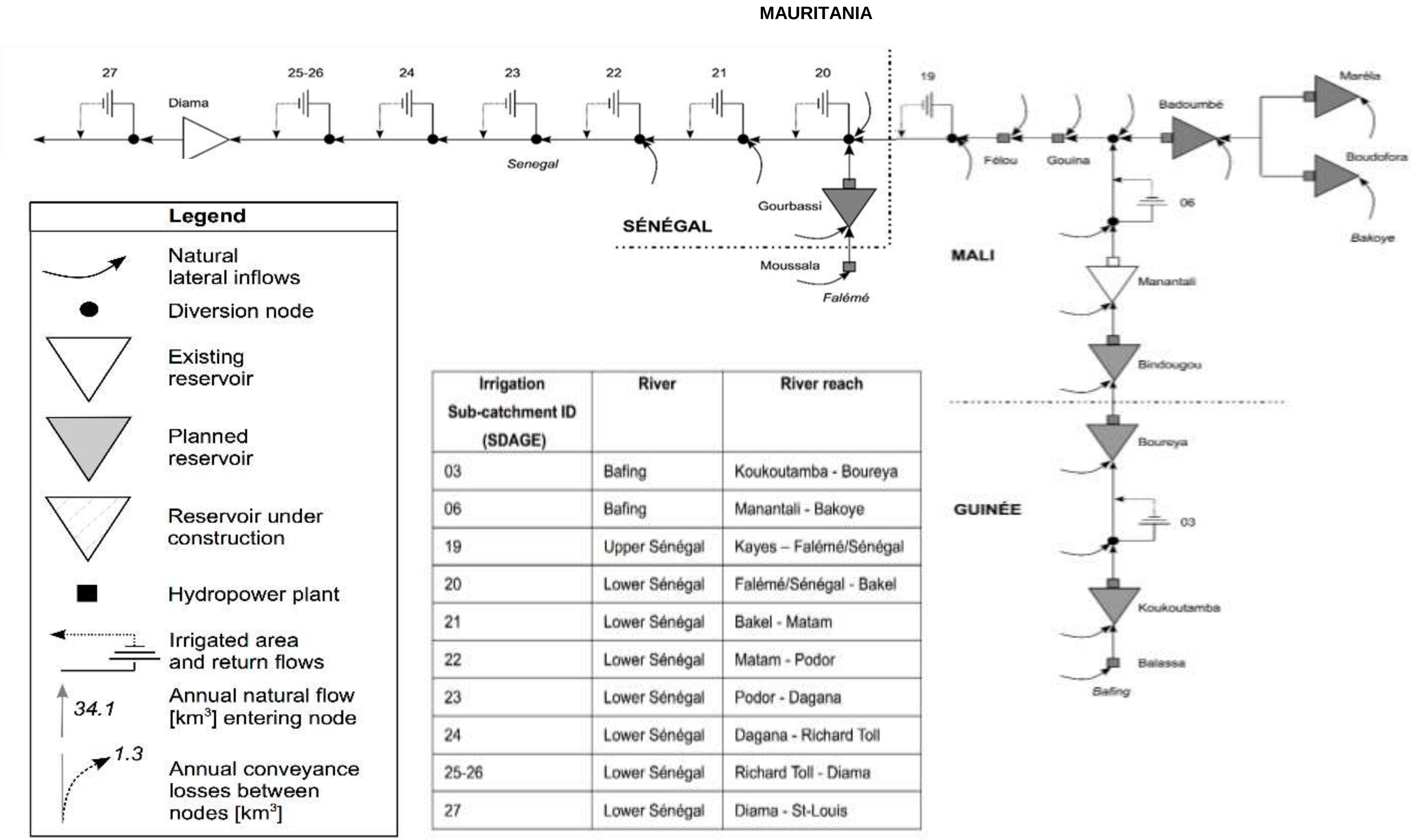
Project background

Enhanced cross-boundary water resource management in the Senegal River Basin (TCP/INT/3602)

River Basin takes 12% of total country areas

- Population in the Basin: 2,6% of total 386 million inhabitants
- Several economic disadvantages:
  - Low GDP per capita
  - Flat economic growth
  - Temporary lack of food-supply
- Agriculture share of total GDP: 25%
- Artificial engineering in the '80s modified the stream with two main constructions:
  - Manantali dam
  - Diama dam
- **5 types of water utilization:**
  - **Irrigation**
  - **Hydropower**
  - **Navigation**
  - **Flood recession agriculture**
  - **Fishery**

Project background



Irrigation Sub-catchment ID (SDAGE)	River	River reach
03	Bafing	Koukoutamba - Boureya
06	Bafing	Manantali - Bakoye
19	Upper Sénégal	Kayes – Falémé/Sénégal
20	Lower Sénégal	Falémé/Sénégal - Bakel
21	Lower Sénégal	Bakel - Matam
22	Lower Sénégal	Matam - Podor
23	Lower Sénégal	Podor - Dagana
24	Lower Sénégal	Dagana - Richard Toll
25-26	Lower Sénégal	Richard Toll - Diama
27	Lower Sénégal	Diama - St-Louis

Project background

Manantali dam

- **Multipurpose** dam with estimated functions:
  - River's discharge regulation at a rate of 2 500 m^3/s to allow the traditional flood-recession farming;
  - Keep a constant level of 300 m^3/s at Bakel;
  - Irrigation of 350 000 ha with a 11 billion m^3 storage capacity;
  - Producing hydropower with a 800 GWh per;
  - Providing 1 500 km transport line network to assure energy delivery;
  - Ensuring the navigability of the river through a 900 km long part.
- Real maximum capacity is in 540 GWh
- **Electricity production share:**
  - 55% in Mali
  - 30% in Senegal
  - 15% in Mauritania
- **Irrigation share:**
  - 54 700 ha in Senegal
  - 20 400 ha in Mauritania
  - 3 000 ha in Mali
- Experimental flood recession cropping on a maximum 50 000 ha in Mauritanian rice fields
- 477 km^2 surface area provides high level of fishery productivity

Diama dam

- Moderation of **salt water intrusion**
- Control of floodwaters to pass through its sluice gates
- **Irrigation** of 45 000 ha
- 310 million m^3 storage capacity

Project background

	Hydropower Production	Irrigation	Navigation	Recession Agriculture	Fishery
Guinea	Potentially high	None	None	None	None
Mali	High	Low	Very high	Low	High
Mauritania	Very high	Very high	High	High	Low
Senegal	Very high	Very high	High	High	High

Irrigation

- Targeted irrigated area size of Manantali construction was 375 000 ha:
  - Mali: 5 000 ha
  - Mauritania: 130 000 ha
  - Senegal: 240 000
- Only 131 000 ha of equipped land became available for farmers
- Only 84 500 ha of lands is currently cultivated
- Further agricultural development need in several fields:
  - Plant protection
  - Research and development
  - Diversification and intensification

Critical gaps of rural development

Hydropower

- River Basin has an estimated 1 200 MW hydropower potential
- Manantali dam is the main hydropower equipment with 800 GWh expected capacity
- Only 540 GWh is installed on Manantali yet
- Only 200 MW of hydropower is certainly produced Energy demand based on domestic use is not profitable enough
- Electricity consumption varies on wide range (from 41 kWh per capita per year in Mali to 206 kWh per capita per year in Senegal)
- Electricity potential varies over countries, e.g.:
  - Mali relies on hydroelectricity (57%)
  - Senegal's consumption is based on biomass (80%)
  - Mauritania has become net importer of oil

Recession agriculture

- Dominating cultivations: rice and vegetables
- Recession agriculture requires 4.5 billion m^3 water for 40 days period to 50 000 ha expanding irrigation
- Rice productions suffers from import dependency
- Constrains of production:
    - lack of access and management,
    - servicing and renewal problems of machineries,
    - erratic provision of inputs,
    - processing difficulties,
    - marketing difficulties.
- Recession is still in experimental phase

Navigation

- Commercial navigation is not existing
- River has a 900 km navigation potential:
  - improvement of the dredging of 21 limiting shoals,
  - setting up new sea-river coastal navigation system.

Fishery

- Traditional sector and source of additional domestic income of families
- Declining stock and number of species (50-70% decreasing in downstream)
- Manantali reservoir has 2.5 times higher productivity than Sélingué reservoir
- Production volume: 27 kg per ha
- River basin has 3 000 tons per year production potential

Moving from….. Identified gaps in previous strategic documents in Senegal River Basin:

- Incomplete and unavailable data
- Unreached optimal water use trade-off scheme
- Unavailable decision-making methods

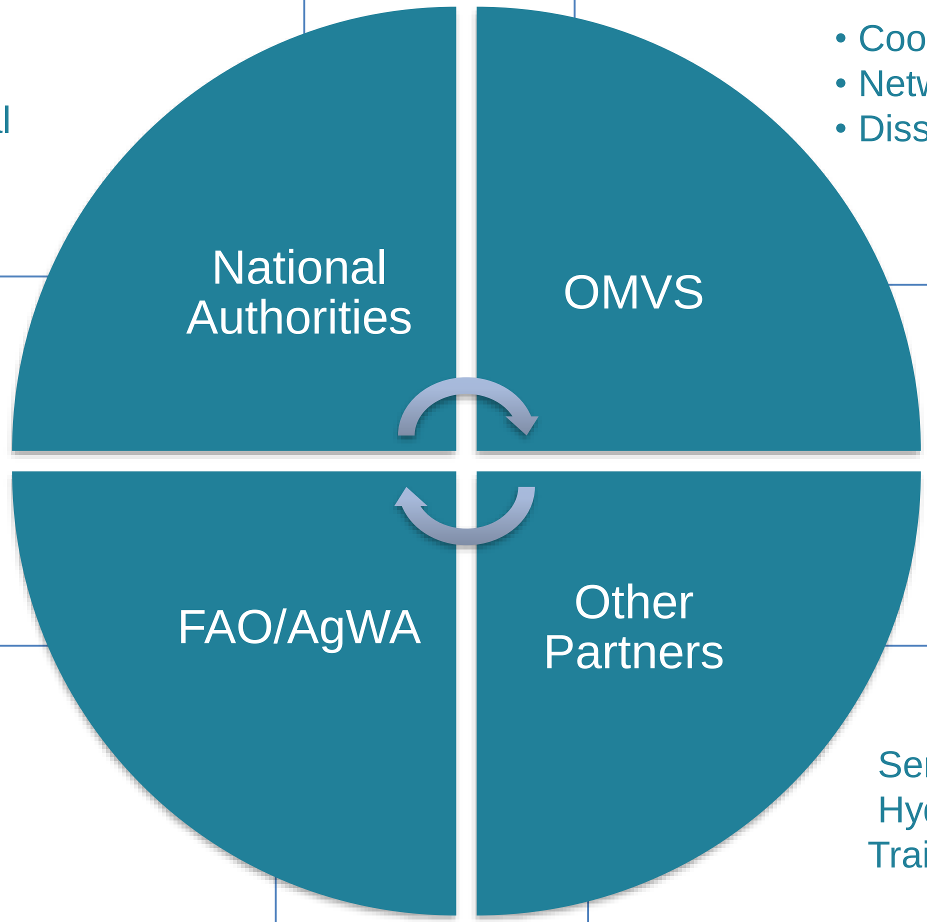
Reaching….. Project expectations

- ✓ Improving tools for multi-objective water resources management (hydro-agricultural component, fisheries component)
- ✓ Establishing hydro-economic modelling for Senegal Basin and sub-basins and increasing understanding of benefits of joint water resources management
- ✓ Identifying cross-boundary investment areas to enhance cooperative and joint management of water resources
- ✓ Assessing trade-offs between water for energy production and water for agriculture/fisheries development

Project objectives

- Consultation
- Technical feedbacks
- Harmonization with local needs

- Coordination
- Networking
- Dissemination



- Technical support/ coordination
- Strategic planning
- Training
- Monitoring

Service provision
Hydro-economic modelling
Training

Project Stakeholders

- Counterpart Regional Institution and Governments: *Organisation pour la Mise en Valeur du Fleuve Sénégal (OMVS)*

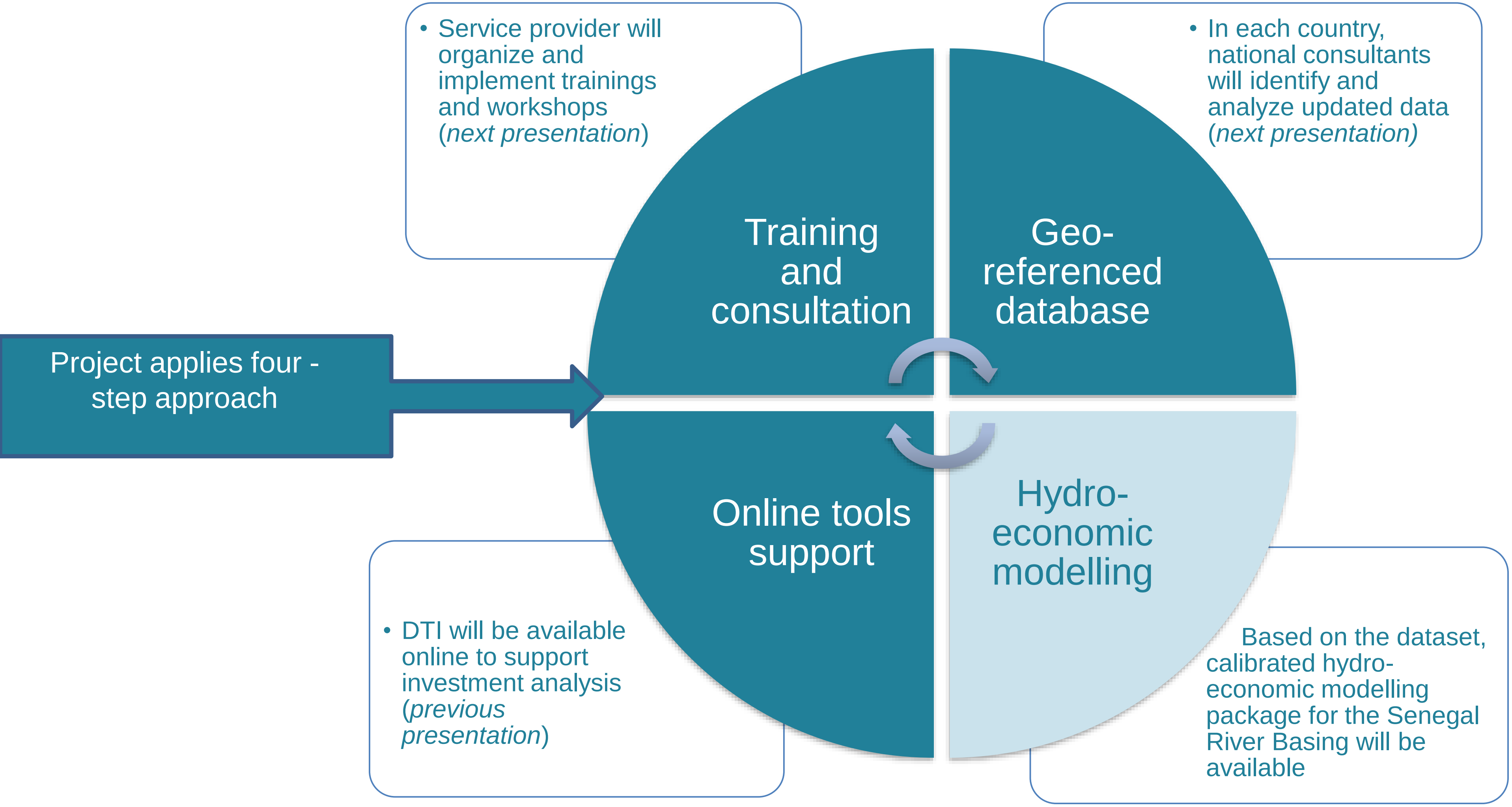
- International Community: *ECOWAS, AgWA, AfDB, IsDB, WB, EU, GIZ, SOGEm, SOGED, SOGENAV, etc.*

- Non-Government and Civil Society Organization:
  - *NGO in conservation and management of water resources (WWF and World Vision);*
  - *NGOs and CSOs (AFRICARE, CARE International, COOPI, OXFAM); national associations of farmers and fishers*

Project Matrix

Goal	**Contribute to improved agricultural development and food security**			
Purpose	**Enhanced cross-boundary water resources management in the Senegal River Basin**			
Indicator	Baseline situation	Target	Means of verification	Assumptions
Number of actions started to implement the SDAGE Plan by country	Current status	At least 2 new actions of the Plan started	Reports from countries on progress made in implementation of SDAGE Plan	No major safety issue in the area concerned by OMVS (Senegal) The commitment of OMVS to support countries
Number of cross-boundary bankable projects in regional investment areas identified within SDAGE, implemented by OMVS and Riparian Countries	None	At least one regional bankable project implemented	Reports from OMVS	No major safety issue in the are concerned by OMVS (Senegal) The commitment of OMVS Funding mobilized
Outputs	Actions			
Improved OMVS and countries capacities for multi-objective water resources management	Update of geo-referntial database; Training on geo-referential database management; Training on cross-boundary water management, OMVS-AgWA roundtable			
Established hydro-economic model for the Senegal Basin and increased understanding of benefits of joint water resources management	Collation and preparation of data for modelling; Model formulation and calibration; Preparation of optimization plan of water resources; Regional stakeholder consultation workshop			
Identified cross-boundary investment areas	Application of context tool; Application of institutional and policy tools; Application of investment tool, Stakeholder consultation workshop			
Assessed trade-offs between water for energy production and water for agriculture/fisheries development	Consultation on assumptions and parameters for trade-off analysis; Assessment of trade-offs; Stakeholder consultation workshop			

Approach/Methodology



Approach/Methodology

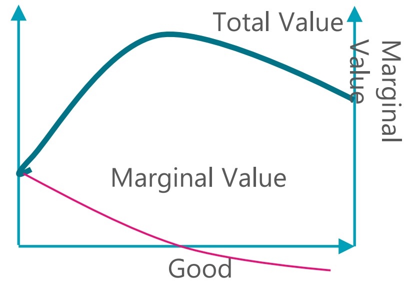
Step	Activities	Description
1.	**Schematization of the water resources system**	An arc-node representation: •major sources of supply (e.g. catchments, reservoirs) •major demand sites (e.g. cities, irrigation schemes
2.	**Performance indicators**	Selection of performance indicators = marginal values of current activities
3.	**Data pre-processing/simulation**	Time series of natural monthly river discharges of: •key statistics, •the characterization of the spatial and temporal persistence (correlation), •the generation of synthetic flow sequences.
4.	**Hydro-economic modeling**	Optimization-based hydro-economic on energy generation, water withdrawals, and river discharges
5.	**Optimization**	Inter-sectoral allocation policies for a future development scenario

Approach/Methodology

Optimal trade-off between activities and balance between countries:

➢ Standard Gross Margins of water related activities:

(irrigation, energy, recession agriculture, fishery and navigation)



➢ Simulation of available water capacity and withdrawal;

➢ Limits of marginal values (maximum and minimum bounds);

➢ Economic optimal balance of water withdrawal between marginal values (maximum net profit of marginal values) with hydro- economic modelling

1. Schematization of the water resources system

- **Water demand types:**
  - **Life-sustaining (constraining factor)**
  - **Production input**
- **Water stock – Life sustaining (urban) demand = Available water stock**
  - **Water Stock**

St+1 - R(rt+lt) – l(it) - et(st, st+1) = st + qt

St: storage in time
rt: uncontrolled outflow in time
lt: controlled outflow in time
it: withdrawal in time
et: evaporation in time
qt: incremental inflow in time

  - **Urban demand**

$$\text{UWD}=\sum_{sd=1}^{sd}[[P_{sd}^{U}\,(1+\mu_{sd}^{U})^{n}+P_{sd}^{R}\sigma_{sd}]K_{sd}^{U}]+[[P_{sd}^{R}(1+\mu_{sd}^{R})^{n}-\;P_{sd}^{R}\sigma_{sd}]\;K_{sd}^{R}]$$

UWD: urban water demand in the River Basin
Pu and Pr: urban and rural population
µU and µR: urban and rural population growth rate
n: time period of forecast
σ: population emigration rate
Ku and KR: urban and rural water use per capita

- **Available water stock = production input**

2. Performance indicators for the Senegal Basin:

- *irrigation* (USD $/ha): economic benefit of additional input to increase capacity of irrigation equipment system;
- *recession agriculture* (USD $/ha): economic benefit of additional input to increase the expansion of inundation;
- *hydropower* (USD $/GWh): economic benefit of additional input to increase capacity of turbines;
- *fishery* (USD $/ha): economic benefit of additional input to increase fish catching;
- *navigation* (USD $/km): economic benefit of additional input to create waterways.

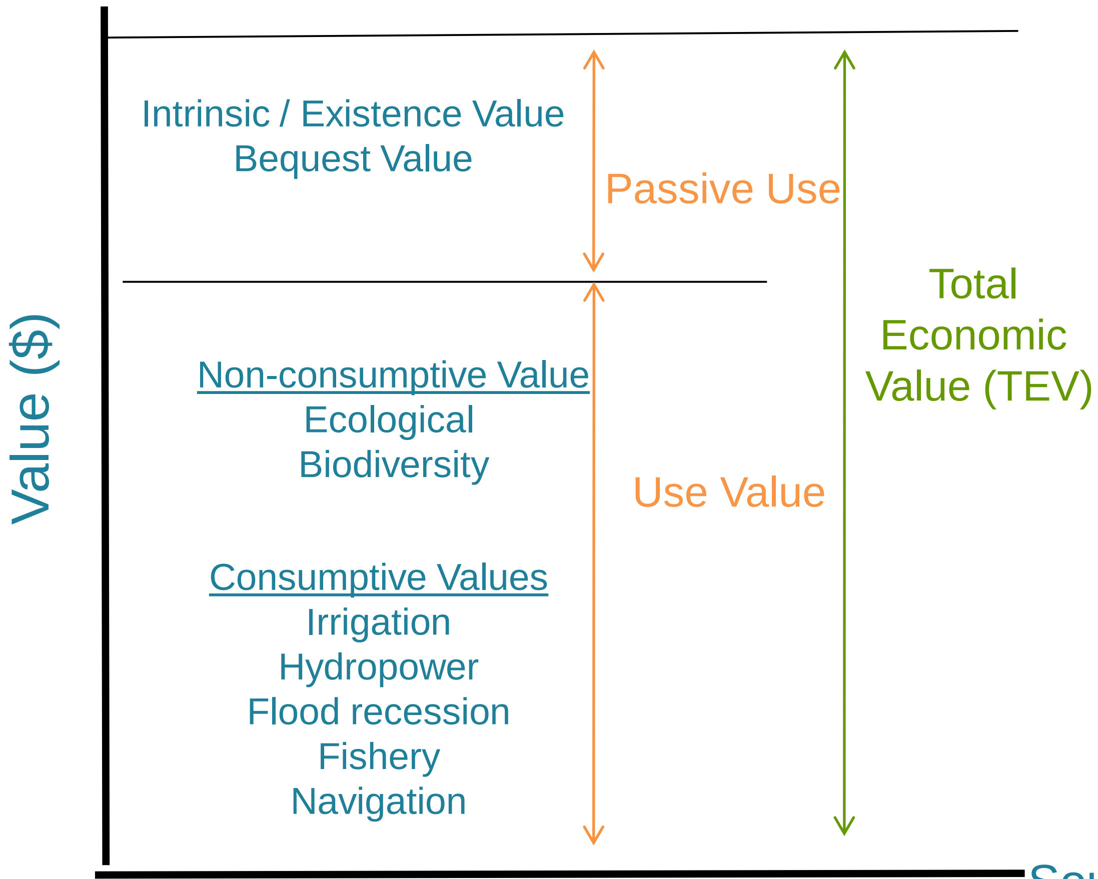
3. Data pre-processing

- Deterministic time series requires time series and unified methodology of data collection (historical or synthetically generated). – *not applicable*

- Stochastic models (uncertainties: non-stationarity of time series or lack of causality) measure the probability distribution of parameters. – *not applicable*

- Dynamic optimization considers the time varying aspect of value:
  - Meta data-analysis
  - Survey
  - Time series analysis

4. Hydro-economic modelling



Sources of Value

- Use
  - Consumptive Use
  - Non-consumptive Use
  - Option
- Passive Use
  - Intrinsic / Existence
  - Bequest

Source: Derived from Rogers, Bhatia, Huber (1998). **Water as a Social and Economic Good: How to Put the Principal into Practice**. http://info.worldbank.org/etools/docs/library/80637/IWRM4_TEC02-WaterAsSocialEconGood-Rogers.pdf

5. Optimization

Hydro-economic model provides monthly allocation policies taking into account:

- Existing and planned water demands in the following sectors: irrigated agriculture, hydropower generation, navigation, fisheries, municipal and industrial uses as well as the environment,
- Physical characteristics of existing and planned hydraulic infrastructure,
- Typical performance of the largest irrigation schemes/areas/projects,
- The variability and uncertainty of natural river discharges throughout the basin
- Different development and management (policy) scenarios

Output of hydro-economic model:

✓allocation decisions throughout the system (reservoir release, water abstractions, reservoir storages, reservoir spills, evaporation losses)

✓marginal water values throughout the system (willingness-to-pay for water)

✓shadow prices associated with the physical and operational constraints (e.g. storage capacity, conveyance capacity, min flow requirement, etc.)

✓net benefits in main sectors

✓cross-border flows/operation rules

The comparative analysis of the different scenarios reveal the trade-off relationships between the conflicting management objectives:

•comparison between scenario B & A will indicate the hydrologic/economic impacts associated with policies, emphasizing **food security** on the rest of the system;

•comparison between scenario C & A will indicate the hydrologic/economic impacts associated with policies, emphasizing **energy security** on the rest of the system;

•comparing scenario D with B and C will reveal the sectoral gains/losses when the basin is optimally managed; while not to neglect **other dimensions** (e.g.: fishery, navigation, etc.).

THANK YOU FOR YOUR ATTENTION!!

Working together to achieve a better integrated cross boundary water management

Meeting the requirements of each sectors and social expectations:

- Requirements of minimum production limits by each sector in river basin development (affirming main sector limits and demanding others, e.g. fishery, navigation.)
- Recent and expected externalities of the sectors (e.g. increased fishing facilities by water storages)
- Influencing social factors on basin-level investment implementation (self-interest versus public interest)
- Invisible social needs and other soft factors of river basin development (traditions, cultural elements, etc.)

Learning from the past:

- Lessons of the small-scale irrigation development in the ‘80s
- River basin development in the past (what worked and what did not)