Module 8
Balancing Water Supply Demand

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Module objectives

- Discuss water related problems in the ESCWA region.
- Discuss the available options for closing the supply-demand gap in ESCWA countries.
- Describe planning criteria within the IWRM principals.
- Develop a decision process to select suitable options to meet supply demand gap.
- Demonstrate the approach of balancing supply and demand by an exercise.

A Unique Resource

- Every organism, individual, and ecosystem on the planet depends on water for survival.
- Water impacts all aspects of life on the planet
- Poor water management and water shortages can lead to disease, malnutrition, reduced economic growth, social instability, conflict, and environmental disaster.

The Global Water Budget

Global Water

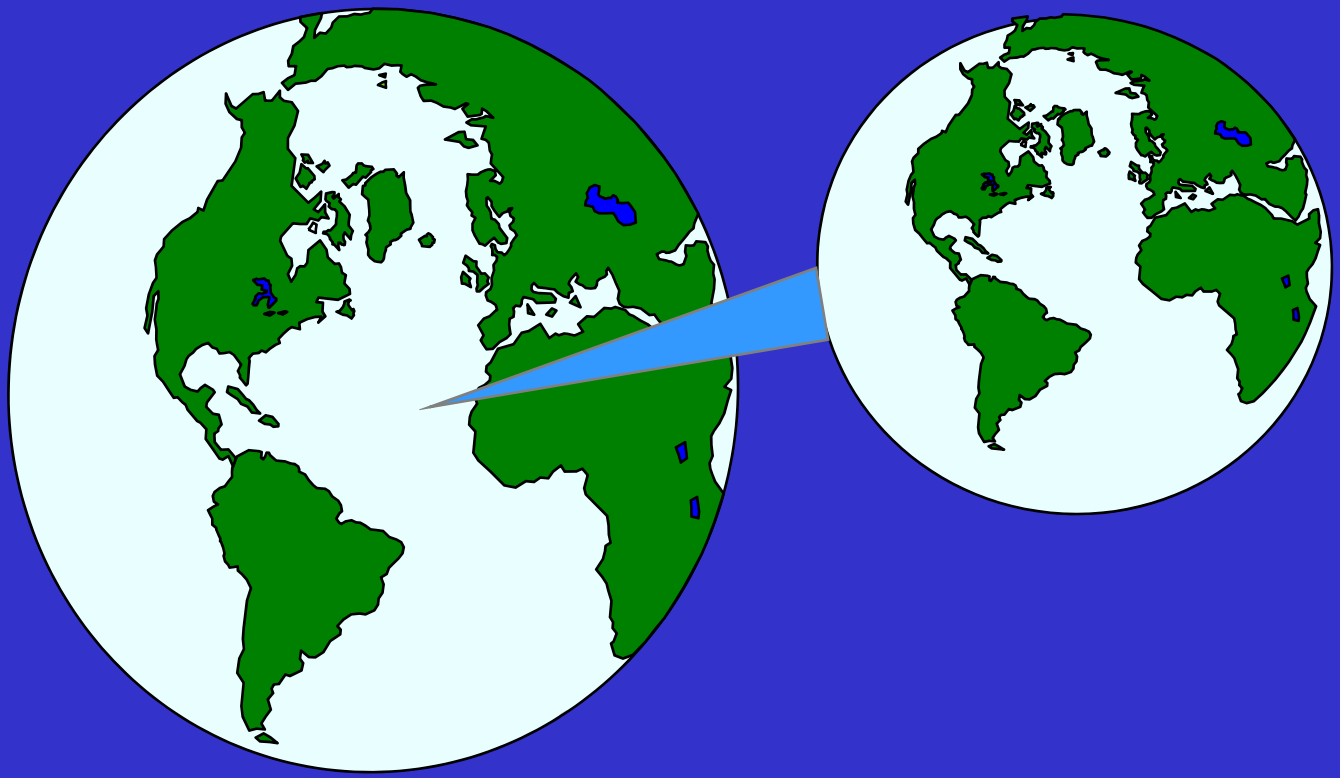
97% Seawater

3% Freshwater

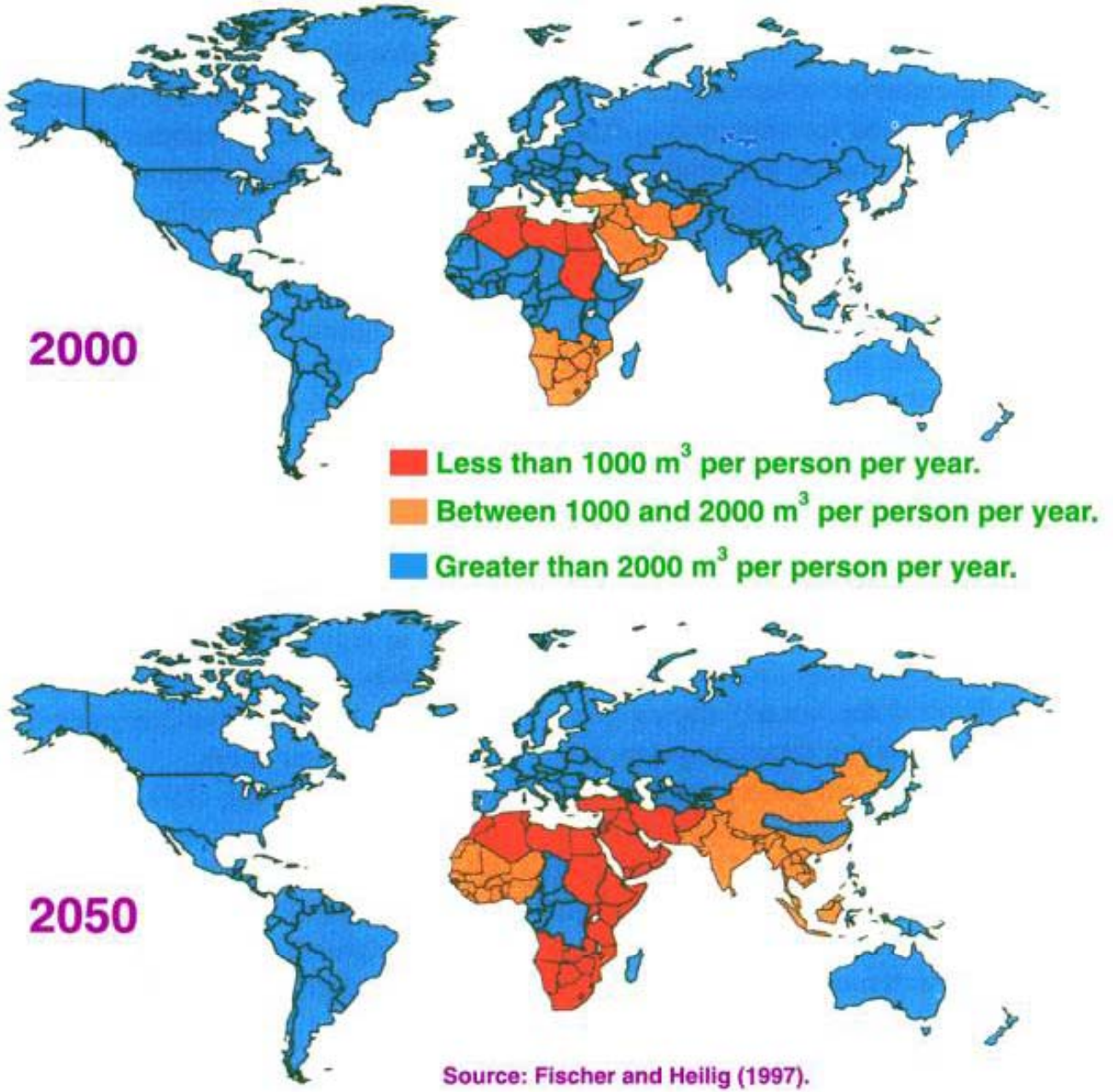
Global Freshwater

87% Not Accessible

13% Accessible (0.4% of global)



Global Water Scarcity



Source: Fischer and Heilig (1997).

Causes of Water problems in the ESCWA:

- Lack of awareness in the public sector of the need for the rational use and management of water resources;
- Outdated water legislation and non-existent enforcement mechanisms;
- Fragmented water institutions and ineffective coordination of related water activities at the national level;

Causes of Water problems in the ESCWA:

- Natural water scarcity owing to the arid, semi-arid and extremely arid climates;
- Lack of up-to-date information on the quantity and quality of available and potential water resources and of reliable forecasts on water demand;
- The general absence of comprehensive national planning and well-designed policies for water resource exploitation and use and demand projections with overall socio-economic development plans;

Causes of Water problems in the ESCWA

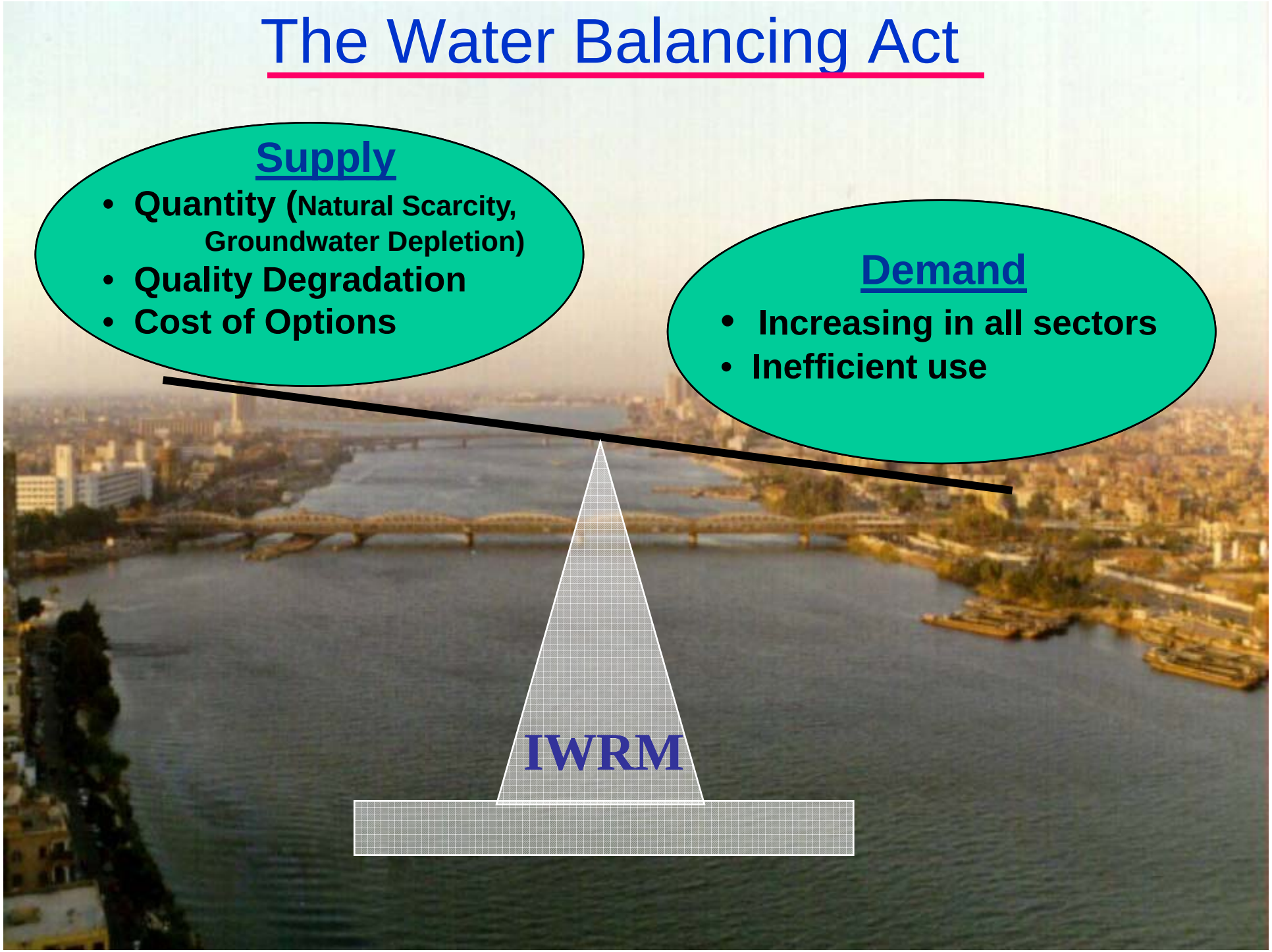
- The absence of technical cooperation between ESCWA member countries at the regional or subregional level in the exploration and development of new resources, particularly of shared rivers or groundwater basins;
- Lack of adequate financial resources to efficiently develop non-conventional water resources, particularly desalination and wastewater reuse facilities, as well as hydraulic structures and distribution systems.

	Conventional water resources[a/,b/,c/]				Non-conventional water resources					
Country/area	Surface water	Ground - water use	Ground-water recharge	Total renewable (mcm)	Desalinated water	Waste-water and drainage reuse	Total renewable and non-conv. res., (mcm)	Water consump.	Utilization %	Groundwater dependency (%)
Bahrain	0.2	258	100	100.2	75	17.5 (3)*	192.7	350.7	181.99	73.57
Egypt	55 500	4 850	4 100	59 600	6.6	4920 (3800)	64526.6	65 276.6	101.16	7.43
Iraq	70 370	513	2 000	72 370	7.4	1500	73877.4	72 390.4	97.99	0.71
Jordan	350	486	277	627	2.5	61	690.5	899.5	130.27	54.03
Kuwait	0.1	405	160	160.1	388	30	578.1	823.1	142.38	49.2
Lebanon	2 500	240	600	3 100	1.7	2	3103.7	2743.7	88.4	8.75
Oman	918	1 644	550	1 468	51	23	1542.0	2636.0	170.95	62.37
Qatar	1.4	185	85	215	131	28	245.4	345.4	140.75	53.56
Saudi Arabia	2 230	14 430	3 850	86.4	795	131 (24)	7006.0	17 586.0	251.01	82.05
Syrian Arab Republic	16 375	3 500	5 100	6 080	2	1447 (1270)	1447.0	21 324.0	93.02	16.41
United Arab Emirates	185	900	130	21 475	455	108	878.0	1 648.0	187.7	16.41
West Bank & Gaza	30	200	185	315	0.5	2	217.5	232.5	106.9	54.61
Yemen	2 250	2 200	1 400	3 650	9	52	3711.0	4511.0	121.56	86.02
Total	150 709.7	29 811	18537.0	169 246.7	1924.7	8321.5	179492.9	190 766.9		48.77

Table 2. Past and projected water demand for the ESCWA region, 1990, 2000 and 2025
(*Millions of cubic metres*)

Country/area	1990			2000			2025			Total demand		
	Domestic	Agricultural	Industrial	Domestic	Agricultural	Industrial	Domestic	Agricultural	Industrial	1990	2000	2025
Bahrain	112	120	17	132	124	26	169	271	169	249	282	609
Egypt	2 700	49 700	4 600	2 950	59 900	5 350	6 300	69 100	10 900	57 000	68 200	86 300
Iraq	3 800	45 200	1 450	4 300	52 000	9 700	8 000	90 000	10 000	50 450	66 000	108 000
Jordan	190	650	43	388	791	63	700	900	160	883	1 242	1 760
Kuwait	295	80	8	375	110	105	1 100	140	160	383	590	1 400
Lebanon	271	875	65	312	950	150	1 100	2 300	450	1 211	1 412	3 850
Oman	117	1 150	5	262	1 500	85	630	1 500	350	1 272	1 847	2 480
Qatar	107	109	9	147	185	15	230	205	50	225	347	485
Saudi Arabia	1 508	14 600	192	2 350	15 000	415	6 450	16 300	1 450	16 300	17 765	24 200
Syrian Arab Republic	650	6 930	146	1 280	15 370	480	2 825	19 430	1 300	7 726	17 130	23 555
United Arab Emirates	513	950	27	750	1 400	30	1 100	2 050	50	1 490	2 180	3 200
West Bank and Gaza Strip	78	140	7	260	217	18	800	420	70	225	495	1 290
Yemen	168	2 700	31	360	3 150	61	840	3650	134	2 899	3 571	4 624
Total	10 509	123 204	6 600	13 866	150 697	16 498	30 244	206 266	25 243	140 313	181 061	261 753

The Water Balancing Act



Integrated Water Resources Management

A systematic process for linking water and water-related policy, objectives, and uses to improve decision making in:

- operation and management of natural resources and environmental systems;
- design and implementation of programs and policies.

A coordinating framework for integrating sectoral needs, water and water-related policy, resource allocation, and management within the context of social, economic, and environmental development objectives.

Why IWRM?

- Globally accepted and makes good sense.
- Key element in national water policy.
- Incorporates social and environmental considerations directly into policy and decision making.
- Directly involves the stakeholders.
- Is a tool for optimizing investments under tight financing climate.

Water as a Global Issue

- Water crisis has steadily moved up the global agenda
- The process is driven by
  - water-related health impacts,
  - rapid industrialization,
  - water security, and
  - awakening environmental consciousness

Key Water Challenges and Needs

- Integrated management of water
- Water resources economics
- Political economy of water
- Water supply and sanitation services
- Irrigation/drainage
- NRM and environment
- Water pricing and cost recovery
- Water entitlement and rights
- Water users empowerment
- Sharing of water and its benefits
- Cooperation and conflict resolution
- Energy

IWRM PERSPECTIVE

Principles

Structure

Economic Efficiency

Equity

Environmental Sustainability

Enabling Environment

Institutional Frameworks

Management Instruments

Balance “**water for livelihoods**” and **“water as a resource**”

OUR IWRM TRIANGLE

Ecosystem Sustainability

Enabling Environment

Policy
Legislation
Regulation

Management Instruments

Assessment
Information
Allocation tools

Institutional Roles

Aquifer &
River Basin
Central-Local
Public-private

Economic Efficiency

Social Equity

Management Instruments

Assessment
Information
Allocation tools

Economic Efficiency

Assessment

Cycle applicable components

Information

Setting characterization

Quantity,Quality,Timing,Cost

Demand – Supply – Use –
Protection Alternatives

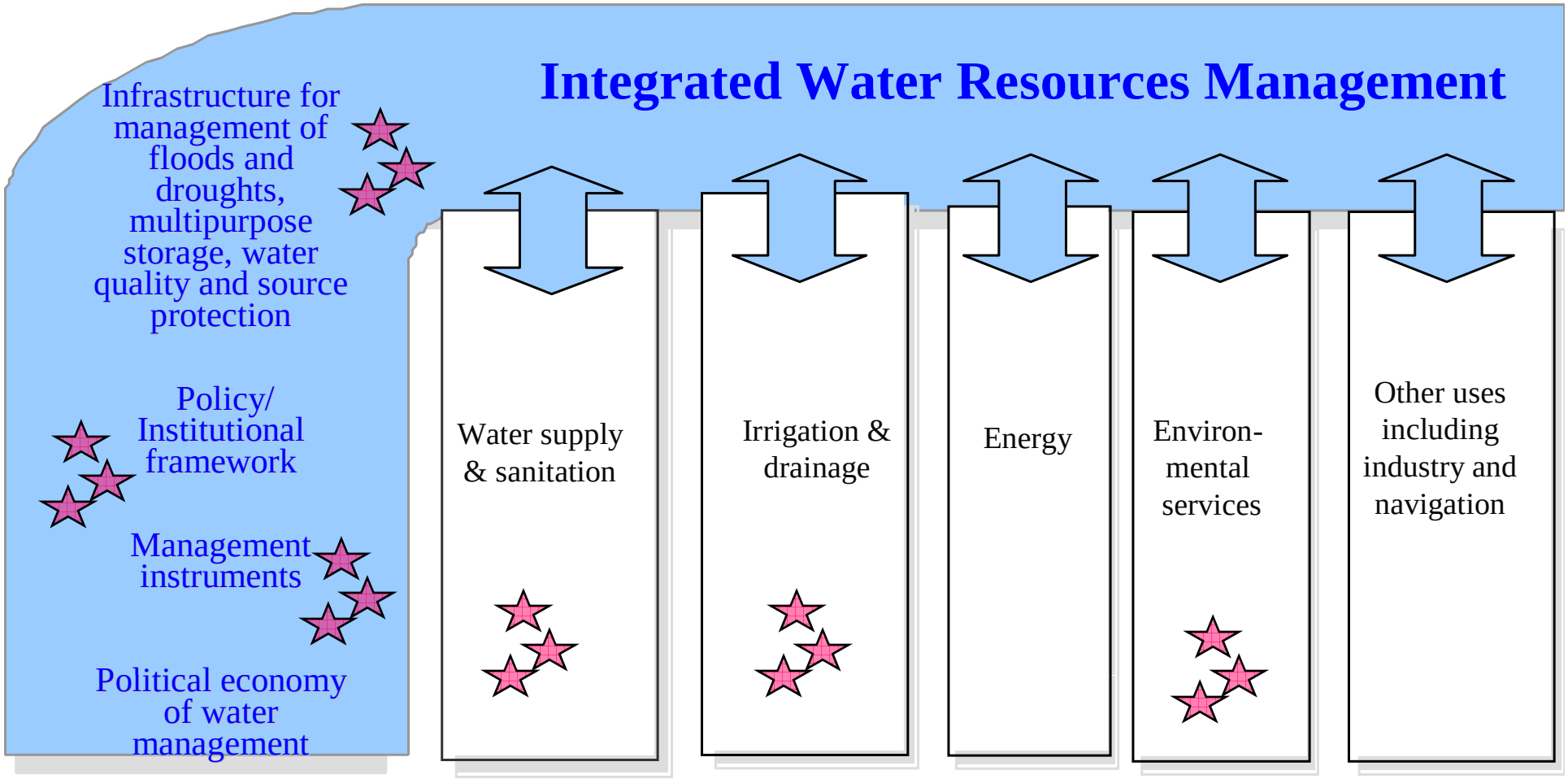
Data (sources, reliability, access, links)

Allocation Tools

DSS models

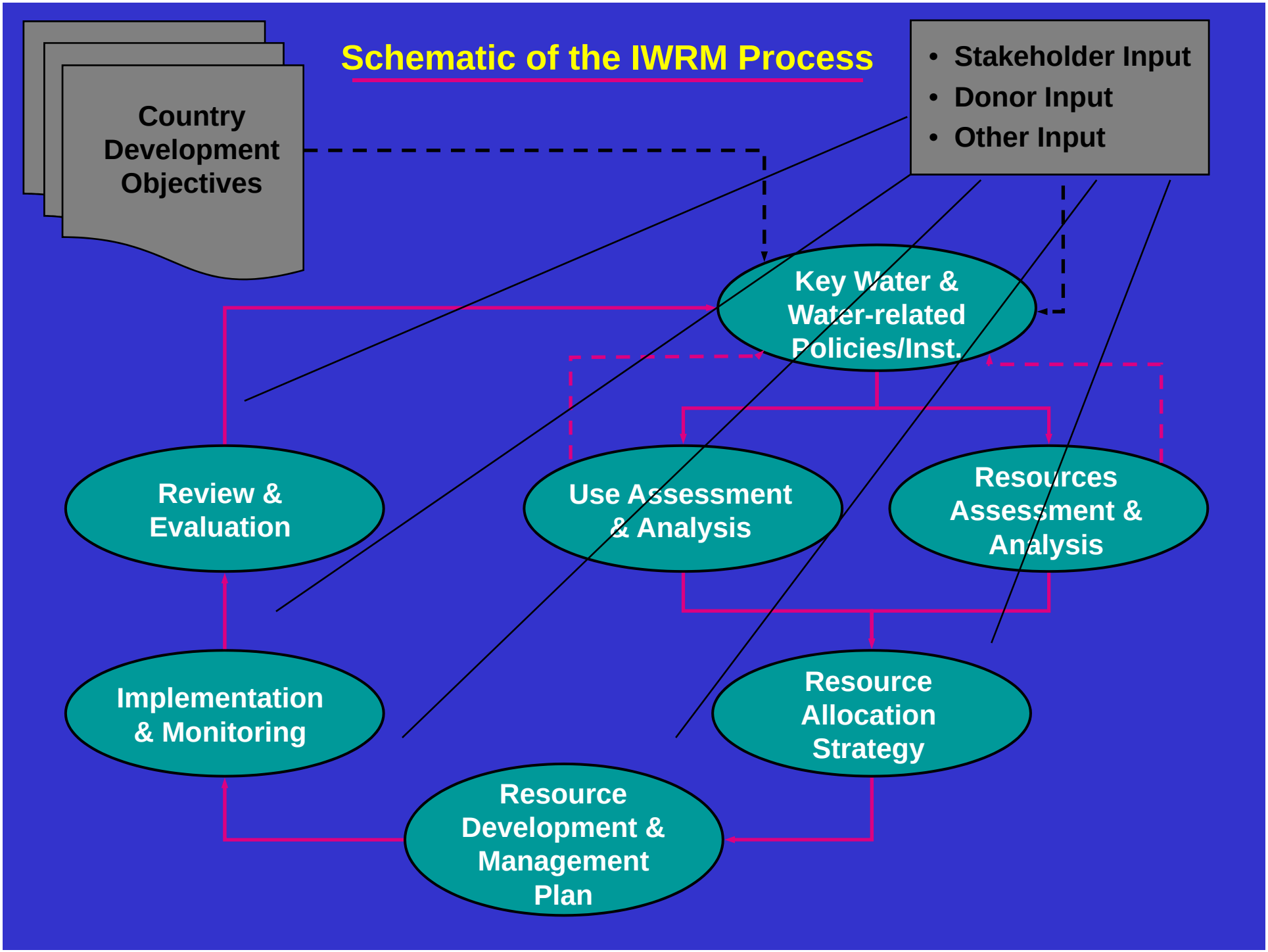
Tradeoff analysis

Dimensions of IWRM

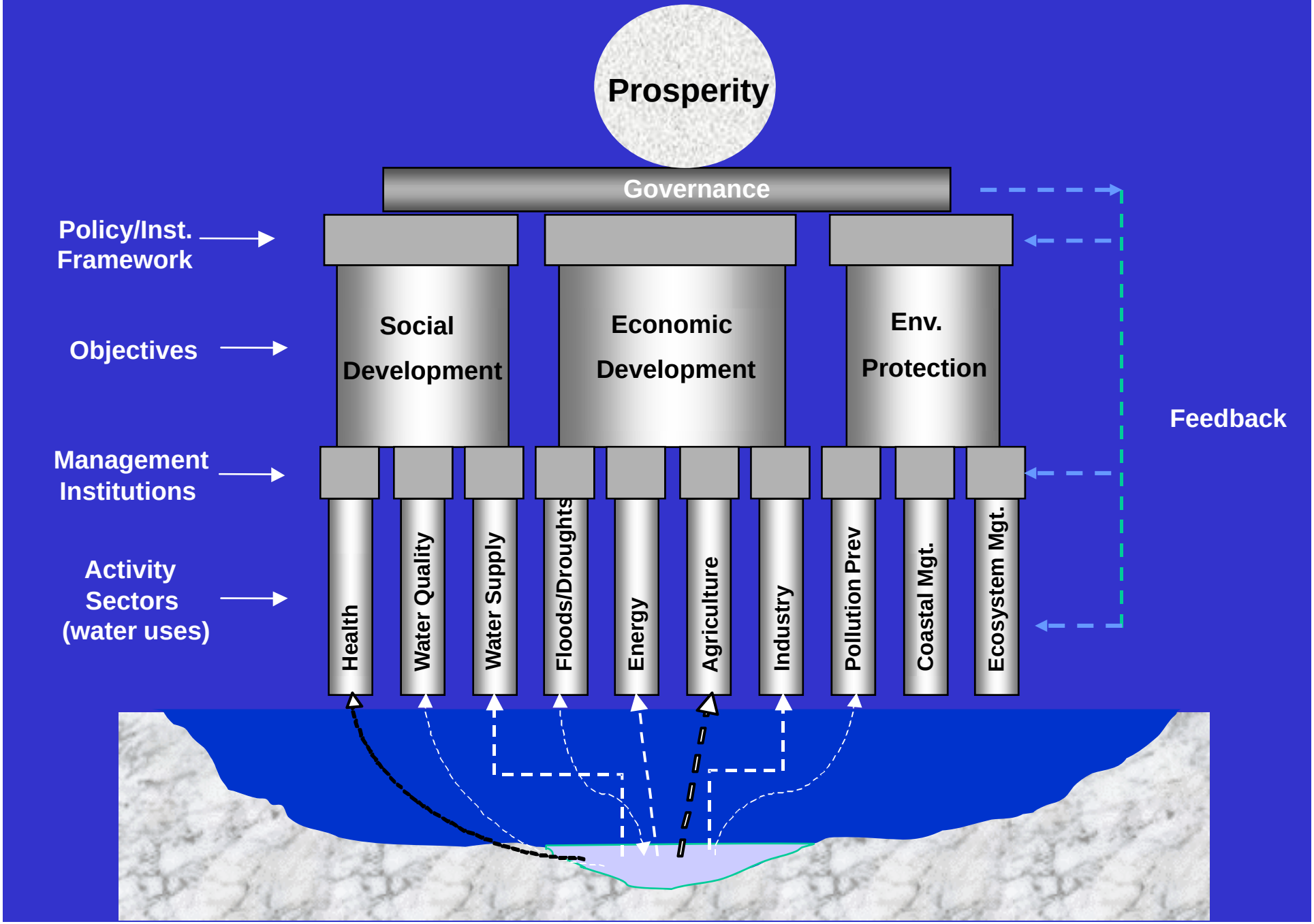


GWP

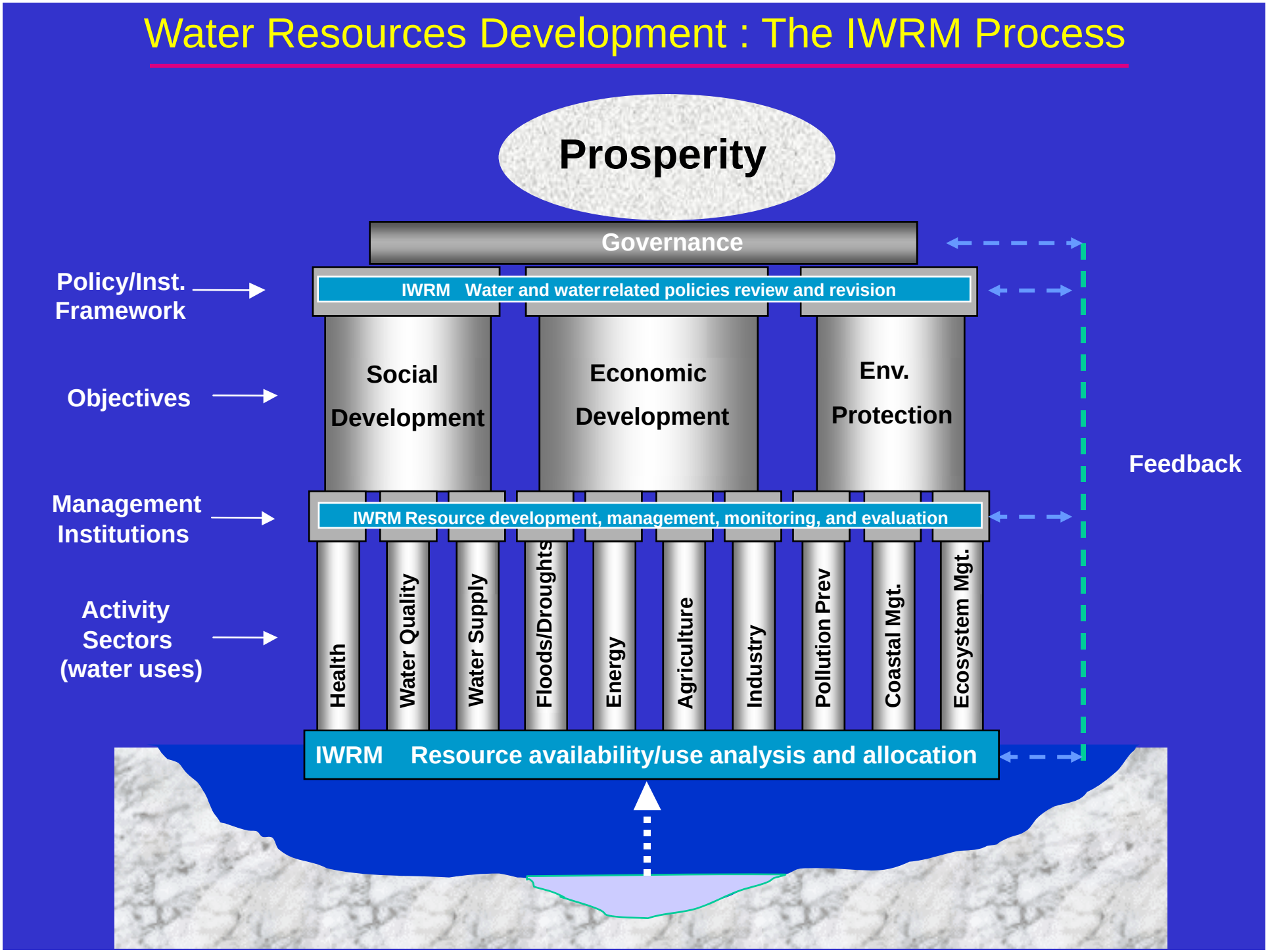
Water Uses


Schematic of the IWRM Process
Country Development Objectives
• Stakeholder Input
• Donor Input
• Other Input
Key Water & Water-related Policies/Inst.
Review & Evaluation
Use Assessment & Analysis
Resources Assessment & Analysis
Implementation & Monitoring
Resource Allocation Strategy
Resource Development & Management Plan

The Water Resources Development Process: Sectoral (or Use) Approach



Water Resources Development : The IWRM Process



Balancing supply and demand consists of the following activities

- Water Demand analysis
- Water resources assessment (WRA)

The main strategic options in various countries of the ESCWA region

Examples…

Strategic options	
I. Options for an optimal utilization of the existing water resources	**In countries**
Increasing water efficiency through the minimization of water losses in all uses of surface and groundwater sources and leakage control.	Egypt, Jordan, Bahrain, the Syrian Arab Republic, Saudi Arabia, Yemen, United Arab Emirates, Lebanon
Motivating the use of water-saving devices in the household and industrial sectors	Jordan and Saudi Arabia
Re-structuring domestic water tariffs to cover at least O&M costs	Egypt, Jordan, the Syrian Arab Republic, Lebanon, Bahrain, Yemen, the West Bank and Gaza Strip

Examples……

II. Options for developing new water resources	
Establishing recharge dams and other hydrological structures to increase reservoir of groundwater	Lebanon, Bahrain, the Syrian Arab Republic, Yemen, United Arab Emirates
Cloud seeding/harvesting	The Syrian Arab Republic and Yemen
Desalination of sea water	All GCC countries and Yemen
Desalination of brackish groundwater	Egypt
Assessing the potential of utilizing brackish water	Jordan
Harvesting rainfall and flash flood waters	Egypt
Evaluating groundwater and surface water potentialities, especially in critical basins	Jordan
Investigating use of seawater for cooling machines	Lebanon

Examples…..

III. Options for water quality management	
Treating industrial wastewater before discharging it into the river or other water bodies	Egypt, Jordan, Yemen
Collecting domestic sewage and treating it before it is discharged back into the system	Egypt, Jordan, GCC countries, Yemen
Controlling and reducing the amount of agrochemicals (fertilizers, pesticides and the other added chemicals)	Egypt
Expanding well-field protection zones	Bahrain
Carrying out an environmental impact assessment for each water project	The West Bank and Gaza Strip

Examples…

IV. Options for capacity building and creating a better environment for potential reforms in water management	In countries
Enhancing training and increasing skills of human resources in the water sector	All countries
Improving data and information systems	All countries
Restructuring water institutions to achieve financial and administrative decentralization and autonomy	Jordan, the West Bank and Gaza Strip, Yemen
Updating legislation, reviewing regulations and enhancing enforcement	Lebanon, Egypt, Yemen, Bahrain, Saudi Arabia, United Arab Emirates
Initiating an intensive public awareness programe to stimulate water conservation	Egypt, Jordan, Saudi Arabia, United Arab Emirates, Bahrain, Yemen, the West Bank and Gaza Strip.

Description of planning criteria

A. Financial viability

1. Fundability
2. Unit cost of water, dollars per cubic meter
3. Affordability

Description of planning criteria….

B. Technical viability

1. Availability of technology
2. Implementability
3. Flexibility and reliability of technology
4. Feasibility
5. Water resources knowledge

Description of planning criteria….

C. Source viability

1. Availability and hydrologic certainty of the source
2. Sustainability of quantity and quality
3. Flexibility of Supply development

Description of planning criteria….

D. Political viability

1. Willingness of participants
2. Political certainty of the source country
3. Compatibility with the international laws and the existing agreements.

Description of planning criteria….

E. Institutional viability

1. **Availability and capacity**
2. **Reliability of institutions**

F. Environmental viability

1. Impacts on the built environment

2. Impacts on the physical and natural environment

Description of planning criteria….

G. Social viability

1. Public acceptance
2. Fulfillment of development needs

Screening of options

Tableau Used in Multicriterion Decision Making
A: Alternatives and C: Criteria

	A_1	A_2	….	A_n
C_1				
C_2				
C_n				

- Symbolically, if wi is the weight assigned to the ith planning criterion by members of the Focus Group, and if rij is the rating of the jth option with respect to the ith criterion, the overall score, Sj, for the jth option is calculated as:

$$Sj = \sum_{i=1}^{n} rij\ wi$$

Case Study

- There is a shortage in an area in water and we want to fill the gap between demand and Supply. What we can do??

1. List all possible options

No.	Option
1	Development of local groundwater sources
2	Supply system improvements- municipal sector
3	Water conservation –municipal sector
4	Supply System improvement-– agriculture sector
5	Water conservation – Irrigated agriculture sector
6	Development of local surface water resources
7	Intensive watershed management
8	Water pricing
9	Intersectoral reallocation
10	Wastewater reuse
11	Desalination of brackish water
12	Desalination of sea water
13	Medusa bags
14	Cloud seeding
15	Mediterranean Sea-Dead Sea desalination
16	Red Sea-Dead Sea desalination

2. Suggested and weights Criteria? Focus group

Financial and economic viability		20%
	Fundability	
	Cost per unit of water	
	Affordability	
Technical viability		13.3%
	Availability of technology	
	Implementability	
	Feasibility	
	Flexibility and reliability of technology	
Source viability		22.4%
	Availability and hydrologic certainty	
	Sustainability of quantity and quality	
	Flexibility of supply development	

Suggested Criteria

Political viability		21%
	Willingness of participant countries	
	Political certainty of source country	
	Compatibility with international laws	
Institutional viability		7.1%
	Availability and capacity of institutions	
	Reliability of institutions	
Environmental viability		8.8%
	Impacts on the built environment	
	Impacts on the physical and natural environment	
Social viability		7.4%
	Public acceptance	
	Fulfilment of development needs	

3. Analysis of options analysis

Example…… Option No. 1

- **Development of Local Groundwater Sources**

- **Concept:** The total potential renewable groundwater resource in the West Bank is 601Mcm/yr and 78 Mcm/yr of brackish water for further development.

- **Technology/Implementation**: The technology for groundwater extraction is readily available.

- **Costs:** The unit production cost of local groundwater in the West Bank ranges between $ 0.25 and $0.30/m3. Financing, distribution, and treatment would increase these costs.

Analysis..

- **Source Water**: From the point of view of hydrologic uncertainty, the availability of the resource is reasonably well known and dependable. Production can be sustained up to the total renewable capacities of the aquifers.
- **Political**: The Palestinian share of the groundwater resources in the West Bank in not yet defined. Therefore, the extent to which the Palestinians may develop these resources in the future is a function of the Final Status Negotiations. Utilisation of groundwater resources would provide Palestinians with a high degree of independence in the control of their water resources.
- **Institutional:** Management institutions necessary for effective utilisation of groundwater resources would not have any out-of-the ordinary or exceptional staffing, training, or manpower requirements.

Analysis…

- **Environmental**: The development of conventional water sources must take into account the sustainability of these resources. Groundwater development must be performed so that safe yield of aquifers in not exceeded.
- **Social:** Public acceptance of the use of additional groundwater supplies would be limited only by the price charged to water users.

Calculations…

Criteria		Weights		
		Mean	Option 1	Option 2
Financial and economic viability		20	3/5	5/5
	Fundability			
	Cost per unit of water			
	Affordability			
Technical viability		13.3	2/5	4/5
	Availability of technology			
	Implementability			
	Feasibility			
	Flexibility and reliability of technology			

Calculation…

Source viability		22.4	1/5	5/5
	Availability and hydrologic certainty			
	Sustainability of quantity and quality			
	Flexibility of supply development			
Political viability		21	2/5	1/5
	Willingness of participant countries			
	Political certainty of source country			
	Compatibility with international laws			

Calculations

Institutional viability		7.1	4/5	2/5
	Availability and capacity of institutions			
	Reliability of institutions			
Environmental viability		8.8	4/5	3/5
	Impacts on the built environment			
	Impacts on the physical and natural environment			

Selection?

Social viability		7.4	3/5	5/5
	Public acceptance			
	Fulfilment of development needs			

Based on the above table we can see that:
Score of option 1 = 20*3/5 + 13.3*2/5 + 22.4*1/5 + 21*2/5 + 7.1*4/5 + 8.8*4/5 + 7.4*5/5 =
Score of option 2 = 20*5/5 + 13.3*4/5 + 22.4*5/5 + 21*1/5 + 7.1*2/5 + 8.8*3/5 + 7.4*5/5 =

The option who has the highest score is better.