

Research Vs. Water Challenges in Egypt

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Centers of Excellence for Agriculture and Water

Center of Excellence for Water

NATIONAL WATER RESEARCH ROADMAP

UC DAVIS UC RIVERSIDE UC SANTA CRUZ



أكاديمية البحث العلمي والتكنولوجيا
Academy of Scientific Research & Technology



Waters
THE SCIENCE OF WHAT'S POSSIBLE.™



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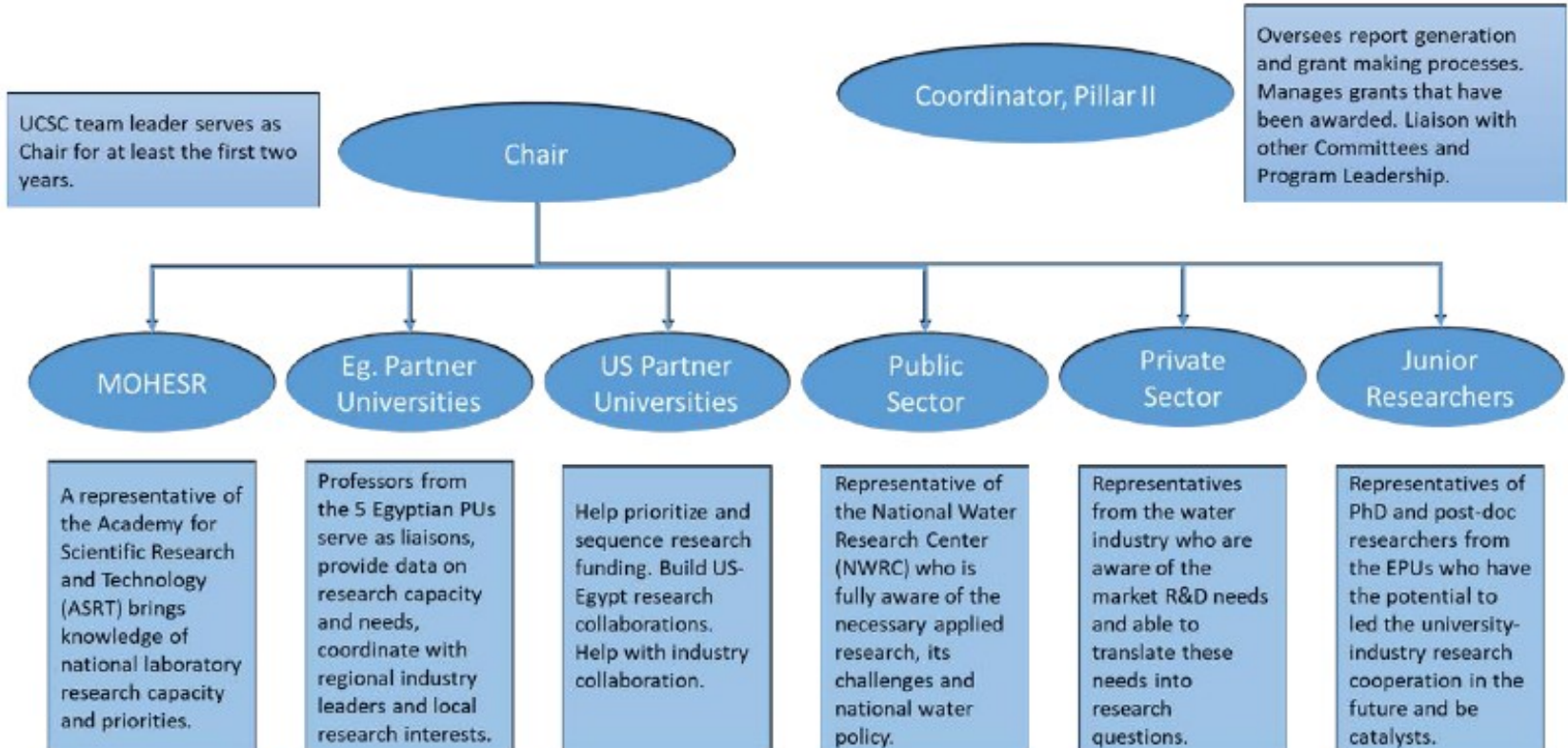
Amriton



apogee
INSTRUMENTS



The Structure of the Research & Policy Committee



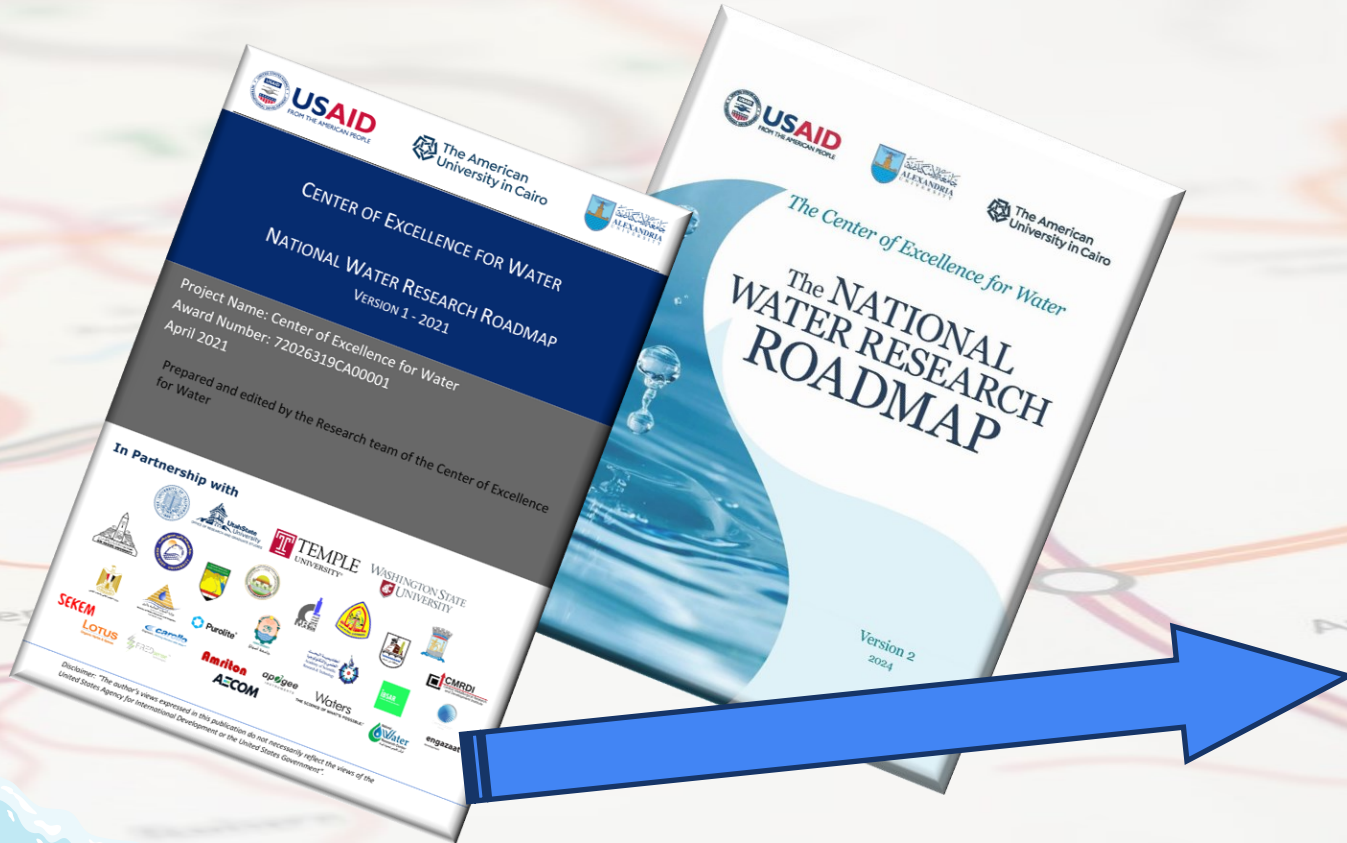
Research vs. Real-World Problems

Research plays a crucial role in solving challenges by generating new knowledge, developing innovative solutions, and informing decision-making.

- Identify & understand the problem – including root causes, all the complexities, intricacies and implications
- be able to find workable solutions –experimentation, analysis, vision, explore possibilities
- work towards that solution – implement real change
- evaluate success & improving practices – to find out if problem solving/change strategies have been successful

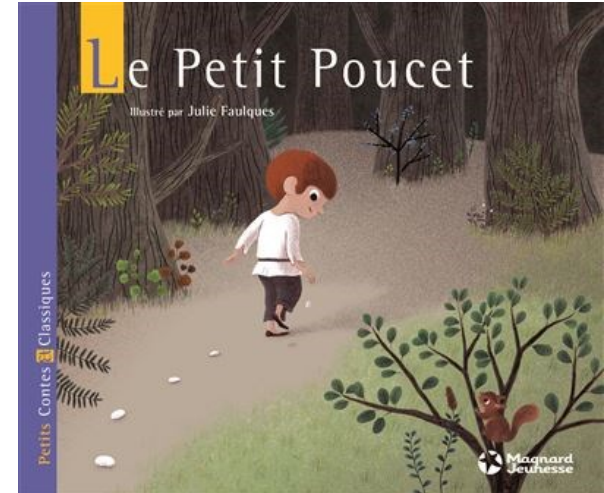


National Water Research RoadMap



The importance of having a Research Roadmap

- **The NWRR will help identify Egypt's most urgent research needs:** Helps direct resources to the most critical research topics to address societal challenges.
- **Defining Objectives:** Establishes goals for interconnected research topics and highlights the importance of addressing key water research questions.
- **Engaging the Private Sector:** Involves the private sector in identifying research needs, adopting innovations, and participating in research development and execution.
- **Increasing Funding:** By linking societal needs with research, the NWRR can boost funding for higher education and scientific research institutions.

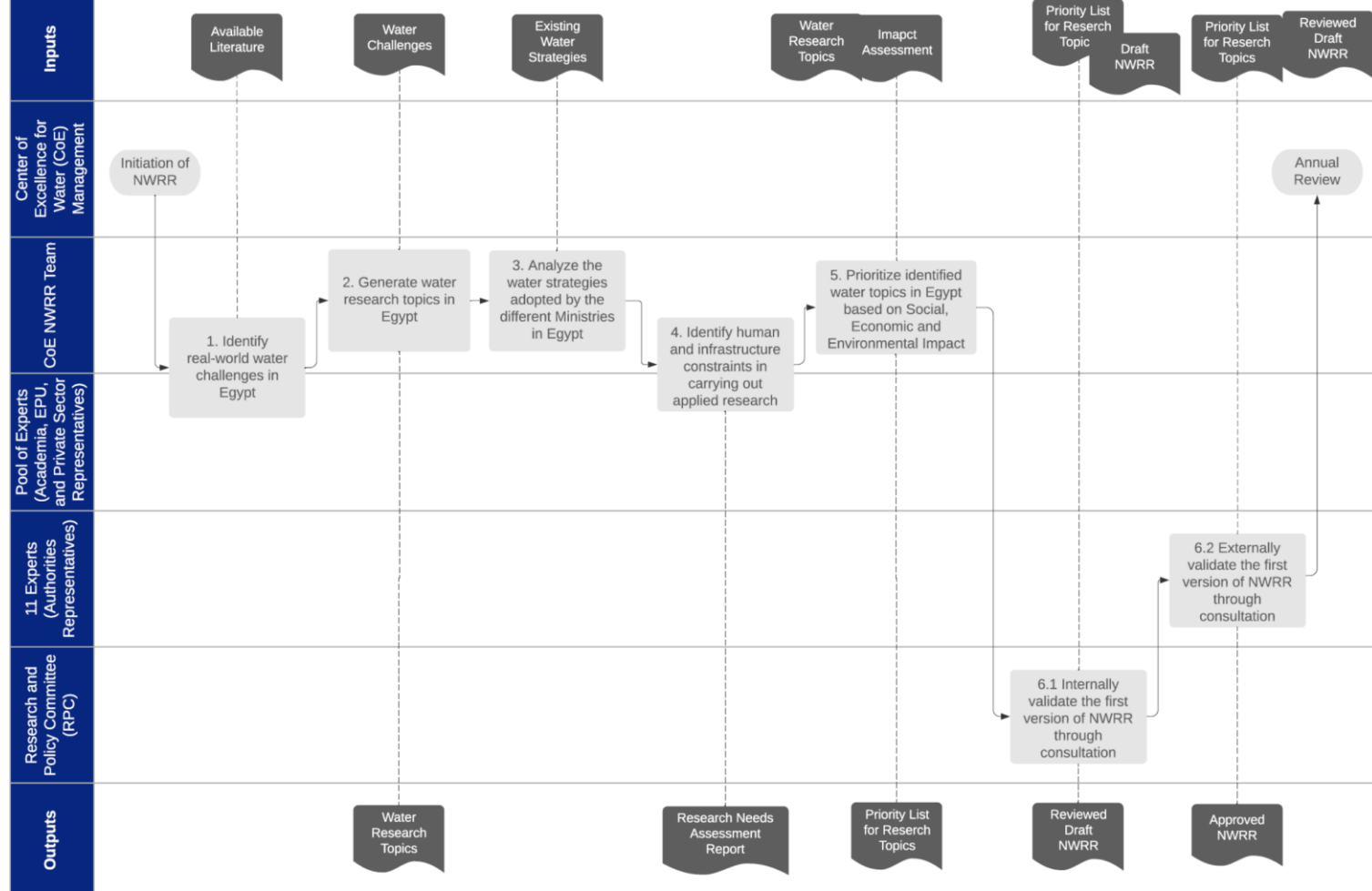


Objectives of the first version of the NWRR

- 1. Stimulate Discussion:** Broaden the focus on Egyptian water research priorities, involving leading scholars, government and private sector leaders, and U.S. experts. Contribute to future forums like Egyptian Water Week.
- 2. Guide Funding and Coordination:** Assist research funding agencies, ministries, universities, the private sector, foundations, and aid agencies in focusing on Egypt's most critical water challenges and necessary research.
- 3. Scientific Prioritization:** Establish a scientific approach to prioritizing research topics using interaction matrices and relative weights for impacts and effects. This approach can be adopted or adapted by various stakeholders to identify or adjust their own research priorities.

The Methodology

- Designating a Center of Excellence-Water Research Team,
- Identifying real-world water challenges in Egypt,
- Identifying water research topics in Egypt (based on literature review, surveys and interviews with Egyptian water scholars),
- Analyzing water strategies adopted by different Ministries in Egypt.
- Identifying human and infrastructure constraints facing the Egyptian Universities and Research Institutes,
- Prioritizing research needs in light of the identified challenges and the role of research in addressing them,
- Validating the first version of the NWRR through consultation with high-level Egyptian and U.S. experts (from academia and the public and private sectors).



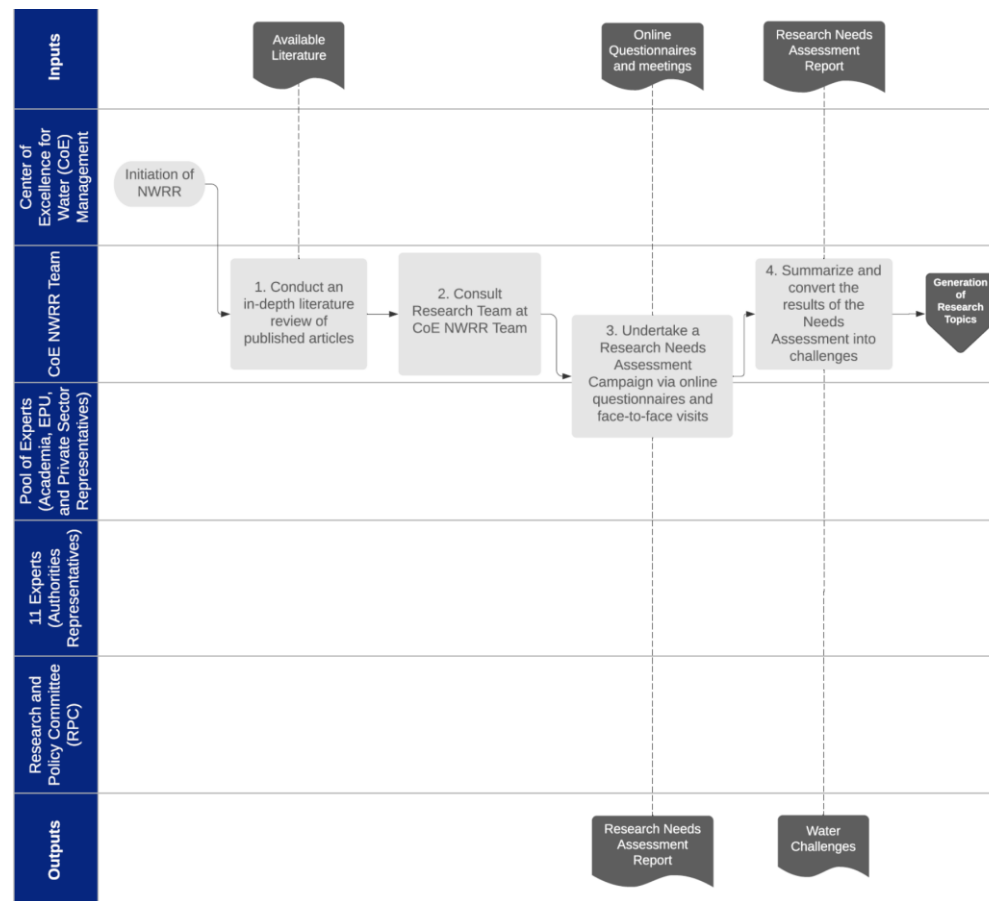
Adopted methodology for the Development of the overall NWRR

Identifying Water Challenges in Egypt (1)

- **Water Scarcity:** (The Nile River (55.5 billion m³/year) represents 95% of the nation's accessible water, with about 85% used for agricultural activities. Water per capita use stood at 630 m³/year in 2017, and with **Egypt's population growth**, it is projected to drop below the 500 m³ limit of absolute water scarcity by 2030.)
- **Climate Change:** Decrease in rainfall, decrease in Nile flow, sea level rise, flood, salt water intrusion, soil salinity, increased evaporation, disturbance in aquatic life,...etc.
- **Transboundary Water and Water Security:** The increase in demand in the upstream Nile countries and their construction of new dams. The Ethiopian Plateau provides 86% of the Nile flow; 59% by the Blue Nile, 14% from Sobat and 13% from Atbara; while the contribution of the equatorial lakes is limited to 14% flowing through the White Nile.
- **Water Quality:** The main sources of water pollution in Egypt are the agricultural, domestic, and industrial sectors.

Identifying Water Challenges in Egypt (2)

- **Aquaculture Sustainability:** Aquaculture contributes approximately 61.3% of the total fish production in Egypt with about 1.14 million tons per year. Restrictions of fresh water. Contamination. Heavy metal contaminations.
- **Sanitation Coverage:** The lack of adequate sanitary facilities in rural areas is a major cause of pollution of both surface and groundwater sources. Health risks. Access to safe water.
- **Water Management:** ‘There is no scarcity of water, only a scarcity of management.’: High Water Consumption, water use efficiency, Irrigation technology, Cropping patterns, land fragmentation, rice cultivation.
- **Water Economics:** does the subsidizing of water services in Egypt encourage the wasteful use of irrigation water and promoting unsustainable decisions.



Adopted Methodology for the Identification of Water Challenges in Egypt

Identifying Topics Requiring Water Research

- Data Collection through questionnaires and face to face visits to stakeholders.
- Research Needs Analysis Campaign to identify the needs and gaps in terms of curriculum, teaching skills, infrastructure, research topics and research capacity.



For Intensity of Use, please use the following scale:
 1: Constantly in use; 2: Occasionally in use; 3: Rarely in use

Laboratory Equipment - Please list the experimental devices or assemblies most in use in your laboratory	Distinguishes the lab (Yes or No)	Intensity of use
1		1 2 3
2		1 2 3
3		1 2 3
4		1 2 3
5		1 2 3
6		1 2 3
7		1 2 3
8		1 2 3
9		1 2 3
10		1 2 3

Needed Equipment - Please list in order of priority the laboratory equipment needed in replacement, to upgrade, or for new research. Briefly explain the reason it is on your list.

1		Replacement (R), Upgrade (U), or New (N)
2		
3		
4		
5		
6		
7		
8		
9		
10		

Examples of Recent Completed or Ongoing Research Projects - Please list name and briefly describe recent water research projects undertaken at your laboratory.

Completed (C) or in Progress (P)	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

National Water Research Roadmap, Version 1 (2021), Center of Excellence for Water – Egypt, Page 54/70

Research Capacity Survey

Intended: This survey covers the water research laboratory you listed in # 4 in your university, use list just the information below. Each section ordinarily has space for 10 answers. Please only use as you are needed. If you have any questions or need distribution on this survey, please contact Brent Stille, Ph.D., at bstille@uvc.edu.
 The box below, please give your Name, Title, Campus, Email address, and relationship to the laboratory.

The box below, please give the name of your laboratory, its location, and a brief description of its main research facilities.

How many permanent staff are employed at this laboratory?	Provide number in next box.
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

How many researchers are affiliated with this laboratory?	Provide number in next box.
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

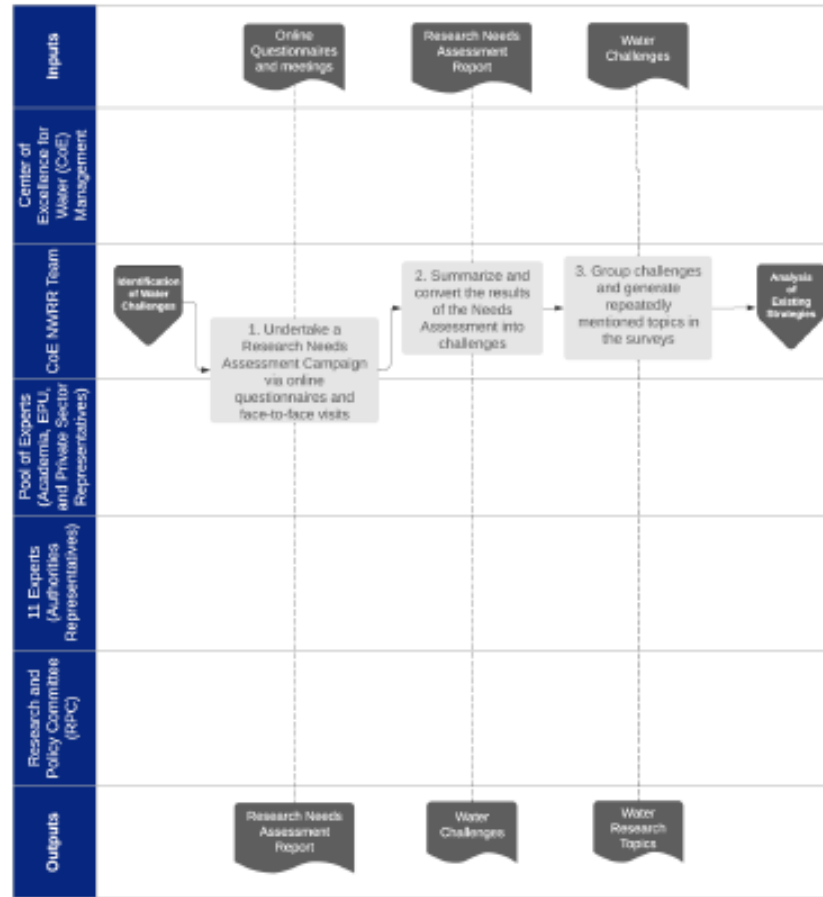
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Use the following scale for the following questions:
 1: Not at all; 2: Very little; 3: Somewhat; 4: To a great extent; 5: Very much

1	What is your current level of Research Collaboration WITHIN YOUR institution?	1 2 3 4 5
2	What is your desired level of Research Collaboration WITHIN YOUR institution?	1 2 3 4 5
3	What is your current level of Research Collaboration AMONG Egyptian institutions?	1 2 3 4 5
4	What is your desired level of Research Collaboration AMONG Egyptian institutions?	1 2 3 4 5
5	What is your current level of Research Collaboration with foreign institutions?	1 2 3 4 5
6	What is your desired level of Research Collaboration with foreign institutions?	1 2 3 4 5
7	If you are currently not collaborating at the level you would like it is because of	
	Lack of interest on your part?	Y or N
	Lack of interest on your potential collaborators part?	Y or N
	Lack of funding to facilitate collaboration?	Y or N
	Lack of recognition of collaborative effort by your institution?	Y or N
	Lack of reward for collaborative effort by your institution?	Y or N
	Lack of support for collaboration by your institution?	Y or N
	Lack of knowledge of potential collaboration within or outside your institution?	Y or N
	Your work is highly specialized and does not lend itself to collaborative research?	Y or N
	Other reasons for lack of collaborative work. Please add comments below.	
8	If you are not currently involved in collaborative research are you interested in collaborative research opportunities?	Y or N

Additional Comments

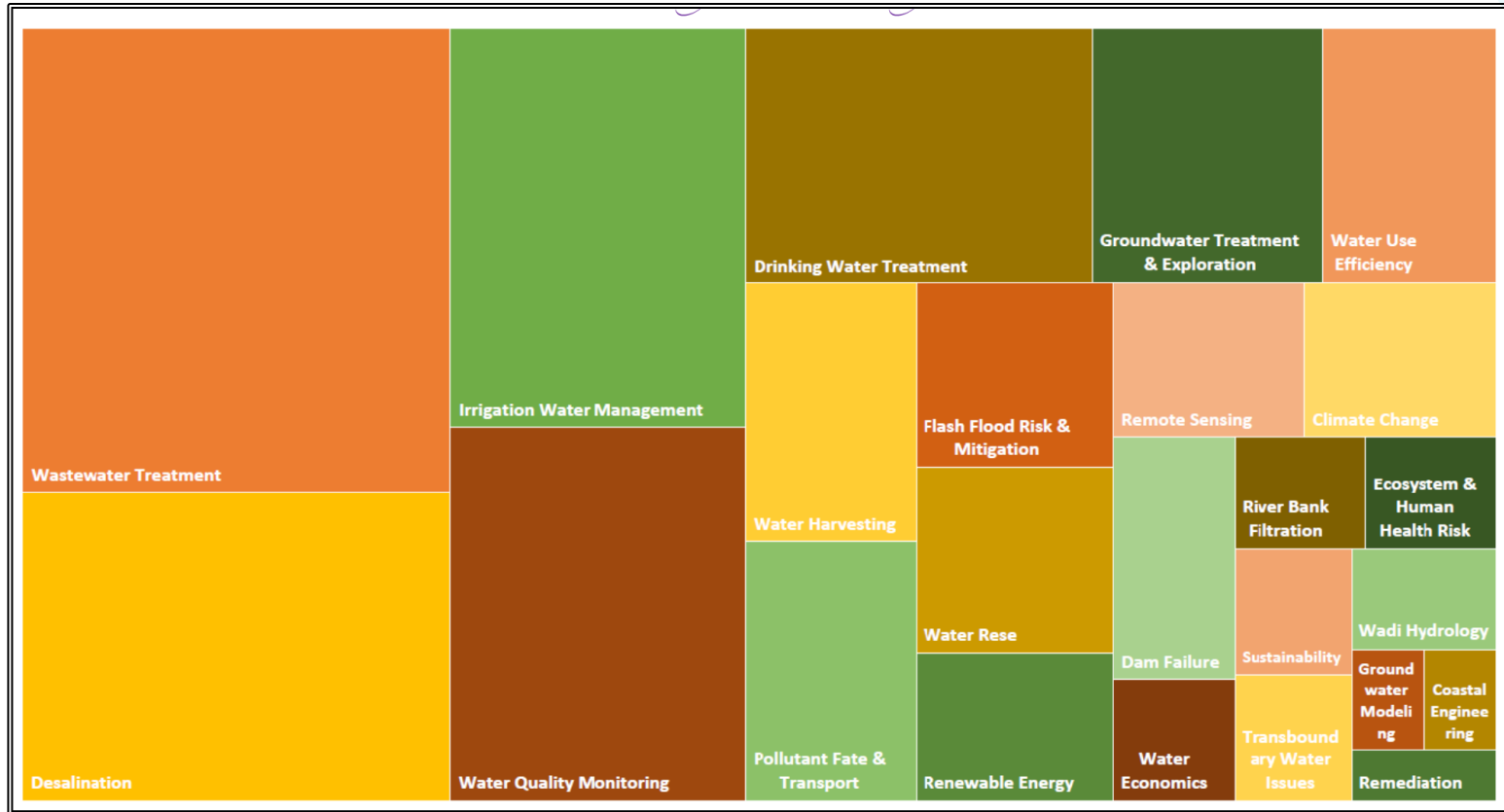


Adopted methodology for the Identification of Research Topics

The results of the Needs Assessment Campaign

1. Wastewater treatment
2. Desalination
3. Irrigation Water Management
4. Water Quality Assessment
5. Drinking Water Treatment
6. Ground Water Treatment & Exploration
7. Pollutant Fate & Transport
8. Fresh Flood Risk & Mitigation
9. Water Reuse
10. Renewable Energy
11. Water Use Efficiency
12. Water harvesting
13. Remote Sensing
14. Climate Change
15. Dam Failure
16. Water Economics
17. Riverbank Filtration
18. Ecosystem & Human Health Risk
19. Sustainability
20. Trans boundary Water Issues
21. Wadi Hydrology
22. Ground Water Modeling
23. Coastal Engineering
24. Remediation

Ranking according to the number of mentions by the respondents during the Needs Assessment.



Research Priorities Identified by Academic Respondents (note: a larger square means a higher priority)

Water Strategies Adopted by Different Ministries in Egypt

Various Egyptian ministries are involved in addressing water challenges related to their missions.

- **Ministry of Water Resources and Irrigation (MoWRI)**

Improving water quality, Rationalizing water use, Enhancing availability of freshwater resources, Improving the enabling environment for Integrated Water Resources Management (IWRM).

- **Ministry of Agriculture and Land Reclamation (MoALR)**

Sustainable use of natural agricultural resources, Increasing water use efficiency in agriculture, Adopting innovative water treatment technologies, Using new agriculture techniques like hydroponics.

- **Ministry of Higher Education and Scientific Research (MoHESR)**

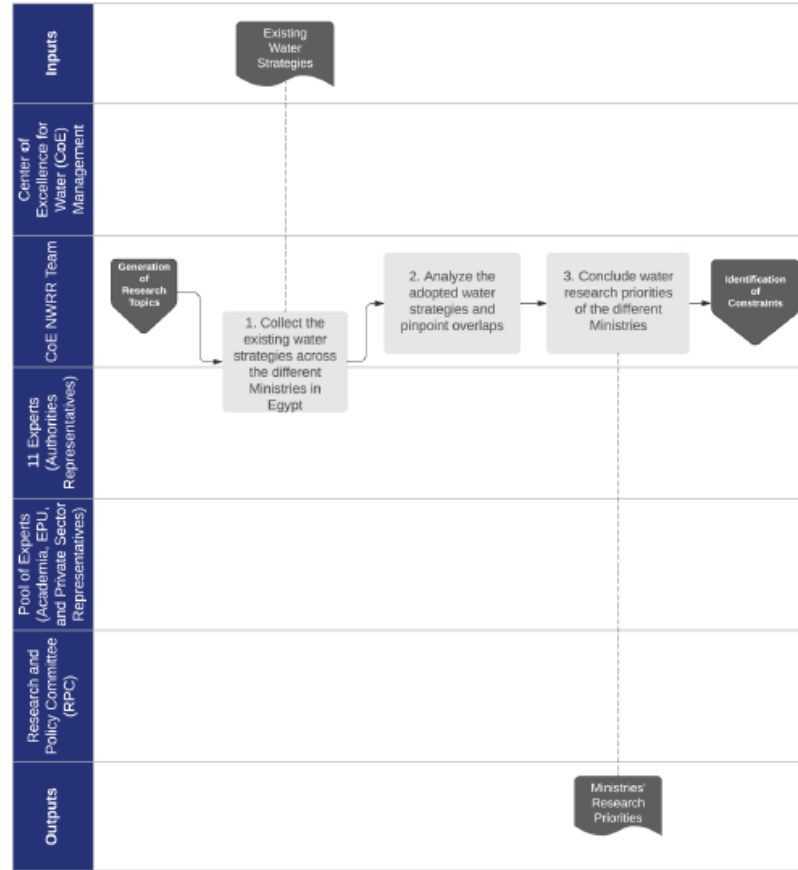
Monitors research and development units related to water, Studies exchange plans with countries facing similar water challenges, Establishes new departments in universities for water use and management, Maintains a database of water research and scientific papers.

- **Ministry of Trade and Industry (MoTI)**

Strategy includes limiting facilities that use surface water due to scarcity.

- **Ministry of Environment**

Seeks innovative tools for assessing environmental impacts of water-using facilities, Studies the impact of global warming on water quality and quantity



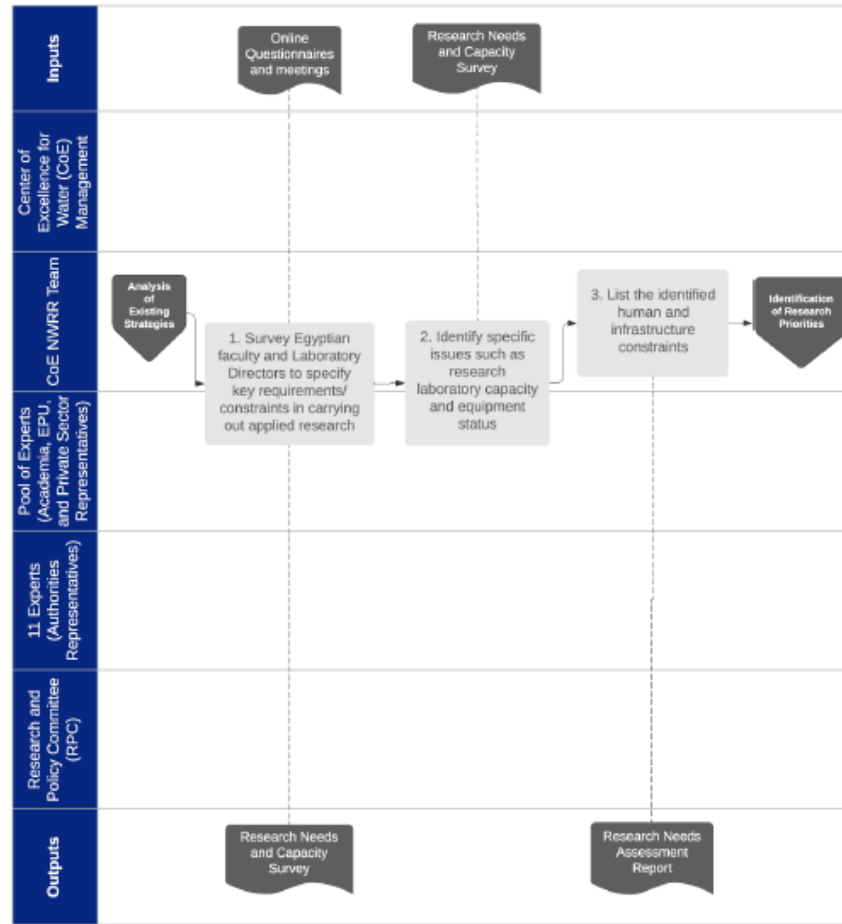
Adopted methodology for the Analysis of Existing Water Strategies

Human Resources Constraints

- **Diverse Expertise Needed:** Research in water involves various disciplines like engineering, chemistry, biology, meteorology, public health, and more.
- **Education and Training:** Universities play a crucial role in training future water researchers and workforce.
- **Support for Higher Education:** Sustained funding for faculty and researchers in water-related fields is essential.
- **Programs and Collaboration:** Promoting exchange programs, knowledge transfer, and collaboration across sectors is vital.
- **New Degree Programs:** There's a need for new graduate programs in areas like Coastal Processes, Water Quality, Groundwater Hydrology, and more.

Infrastructure Constraints

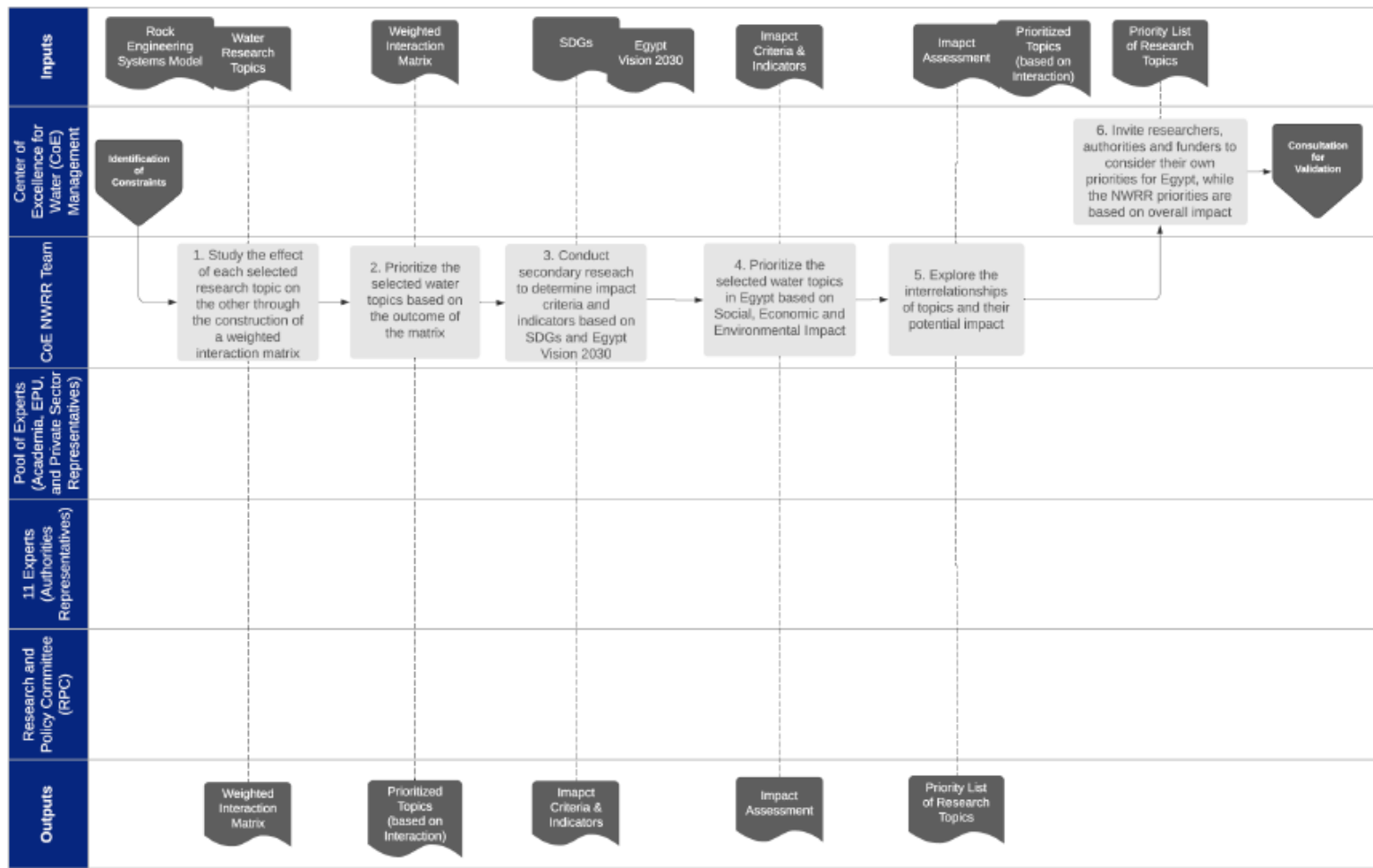
- **Improvement of Facilities:** Continuous improvement of research facilities is necessary.
- **Laboratory Needs:** Key needs include leadership, technical staff, space, equipment, and consistent funding.
- **Equipment Needs:** High demand for water quality assessment equipment.
- **Collaboration:** Sharing resources and facilities among universities, research institutes, and the private sector can optimize use and stimulate innovation.
- **Challenges:** Issues include scheduling conflicts, awareness of resources, and equitable cost allocation for lab use.



Adopted methodology for the Identification of Human and Infrastructure Constraints

Identifying Topics

- Identified water challenges (8) in Egypt are translated into research topics (15).
- Identified research topics are evaluated based on:
 - Potential impact of research outcomes on society, economy, and environment.
 - Alignment with Egypt's Vision 2030 and the United Nations' Sustainable Development Goals (SDGs).
 - How research topics can enhance other goals and programs.
 - Research funding was not considered in prioritization, but researchers and funders may have their own priorities.



Adopted methodology for the Prioritization of Research Topics



Topic 1: Water Scarcity

- I. Water Use Efficiency
- II. Non-conventional water resources

Topic 2: Climate Change

- III. Vulnerability, adaptation, and mitigation of sea level rise
- IV. Temperature Increase and Hydrological Changes

Topic 3: Transboundary Water

- V. Transboundary River

Topic 4: Sanitation

- VI. Safe treated wastewater reuse
 - VII. Centralized/Decentralized Wastewater Treatment
- 



Topic 5: Aquaculture Sustainability

VIII. Increasing Fish Productivity per unit Water

IX. Integrated Aquaculture Systems

Topic 6: Water Quality

X. Industrial Wastewater Management

XI. Remediation and Rehabilitation of Water
Bodies

Topic 7: Water Management in Egypt

XII. Farm Water Management/Irrigation
Modernization

XIII. Integrated Water Resources Management

Topic 8: Water Economics

XIV. Water Allocation

XV. Water Use Incentives



Importance and Prioritization

- All fifteen water research topics are important and need immediate attention, however they require prioritization due to demands like trained personnel, laboratories, equipment, supplies, and multi-year budgets.
- Prioritization of topics was based on their interrelationships and potential impact on society, economy, and environment.
- Different funding sources have different priorities (e.g., ministries, private companies, universities, foundations, and international donors).
- An interaction matrix is used to present the relationships between topics.
- The matrix shows how investment in one research area can support another, solving related problems or building research capacity (Rock Engineering Systems (RES) approach).

Assessment of relative weight of each research topic with respect to each other

Research Topics	1. Water Use Efficiency	2. Non-conventional Water Resources	3. Vulnerability, Adaptation and Mitigation of Sea Level Rise	4. Temperature Increase and Hydrological Changes	5. Transboundary River	6. Safe Treated Wastewater reuse	7. Centralized/Decentralized Wastewater Treatment	8. Increasing Fish Productivity per Unit Water	9. Integrated Aquaculture Systems	10. Industrial Wastewater Management	11. Remediation and Restoration of Water Bodies	12. Farm Water Management/Irrigation Modernization	13. Integrated Water Resources Management	14. Water Allocation	15. Water Use Incentives
1. Water Use Efficiency		+		+	+	+++	+		+++		++	+++	+	+++	+++
2. Non-conventional Water Resources	+		+	+		+++	+++	+	++	+++	++	++	+++	+	+
3. Vulnerability, Adaptation and Mitigation of Sea Level Rise		+		+++					+		++		+		
4. Temperature Increase and Hydrological Changes	+	+	+++		+++			+	+		++	+++	++	++	
5. Transboundary River	+			+++							+	+			
6. Safe Treated Wastewater reuse	+++	+++					+++		++	+	+	+	++	++	++
7. Centralized/Decentralized Wastewater Treatment	+	+++				+++			+	+++	+	+	+++		+
8. Increasing Fish Productivity per Unit Water		+		+					+++	++			++		
9. Integrated Aquaculture Systems	+++	++	+	+		++	+	+++			+	+++	++		
10. Industrial Wastewater Management		+++				+	+++	++							+
11. Remediation and Restoration of Water Bodies	++	++	++	++	+	+	+		+			+	+		
12. Farm Water Management/Irrigation Modernization	+++	++		+++	+	+	+		+++		+			++	+
13. Integrated Water Resources Management	+	+++	+	++		++	+++	++	++		+				
14. Water Allocation	+++	+		++		++						++			
15. Water Use Incentives	+++	+				++	+			+		+			

Interaction Matrix for the identified Research Topics

Research Topics	Number of High Effect "+++"	Number of Medium Effect "++"	Number of Low Effect "+"	Ranked Sum of Effects (Relative Weight) in descending order
2. Non-conventional Water Resources	4	3	6	24
1. Water Use Efficiency	5	1	5	22
6. Safe Treated Wastewater reuse	3	4	3	20
4. Temperature Increase and Hydrological Changes	3	3	4	19
9. Integrated Aquaculture Systems	3	3	4	19
12. Farm Water Management/Irrigation Modernization	3	2	5	18
7. Centralized/Decentralized Wastewater Treatment	4	0	5	17
13. Integrated Water Resources Management	2	4	3	17
11. Remediation and Restoration of Water Bodies	0	4	6	14
10. Industrial Wastewater Management	2	1	2	10
14. Water Allocation	1	3	1	10
8. Increasing Fish Productivity per Unit Water	1	2	2	9
15. Water Use Incentives	1	1	4	9
3. Vulnerability, Adaptation and Mitigation	1	1	3	8
5. Transboundary River	1	0	3	6

Assessment of relative weight of each research topic with respect to each other

Assessment of the Impact of Identified Research Topics on Egypt's Social (8), Economic (4) and Environmental (8) Conditions

Impact		1. Water Use Efficiency	2. Non-conventional Water Resources	3. Vulnerability, Adaptation and Mitigation of Sea Level Rise	4. Temperature Increase and Hydrological Changes	5. Transboundary River	6. Safe Treated Wastewater reuse	7. Centralized/Decentralized Wastewater Treatment	8. Increasing Fish Productivity per Unit Water	9. Integrated Aquaculture Systems	10. Industrial Wastewater Management	11. Remediation and Restoration of Water Bodies	12. Farm Water Management	13. Integrated Water Resources Management	14. Water Allocation	15. Water Use Incentives
Social Impact Category	Reduces adverse impact on agriculture due to irrigation water shortage	+++	+++	+++		+++	++	+	+	+		++	+++	+++	+++	++
	Improves food production output	++	+			+++	++	++	+++	+++	+++	+	+++	++	+	
	Improves rural public health		+				+++	+++		+	+++	+		+		
	Improves urban public health		+++	+	+		+	++			+++	++		+		
	Increases community resilience to natural disasters	+	+	+++	++	++	+					+		++		
	Increases use of safe drinking water		+				+	+++				++		++		+
	Increases use of sanitation systems		+				+	+++				++		++		+
	Increases participation of local communities	+	+		+		+	+++				+	+	++		+
Economic Impact Category	Generates new agricultural employment	+	+	+	+		+	+	+	+			+	+	+	
	Generates new industrial employment							+		+	+					
	Increases economic output	+++	++				+	+	+	+			++			
	Improves energy system operations, including hydropower	+			++									+		+
Environmental	Protects endangered species			+	+++		+					+		+		
	Protects sites of important cultural heritage			++	++									+		
	Improves groundwater and surface water quality	++	++	++		+	+++	+++			+++	+++	+	++		

Impact	Research Topics														
	1. Water Use Efficiency	2. Non-conventional Water Resources	3. Vulnerability, Adaptation and Mitigation of Sea Level Rise	4. Temperature Increase and Hydrological Changes	5. Transboundary River	6. Safe Treated Wastewater reuse	7. Centralized/Decentralized Wastewater Treatment	8. Increasing Fish Productivity per Unit Water	9. Integrated Aquaculture Systems	10. Industrial Wastewater Management	11. Remediation and Restoration of Water Bodies	12. Farm Water Management	13. Integrated Water Resources Management	14. Water Allocation	15. Water Use Incentives
Improves soil quality	+					++	+		+	+	+	+			
Reduces CO ² emissions											+	+	+		+
Enhances adoption of renewable and alternative energy sources		+			+	+			+			+	+		+
Improves air quality						+									
Improves biodiversity		+		++							++	+	+		

Interaction Matrix for the impact for each research topic on Egypt's Social, Economic and Environmental conditions

Research Topic	Social Impact (number of "+")	Economic Impact (number of "+" multiplied by 2)	Environment Impact (number of "+")	Relative weight (sum of impacts) in descending order
7. Decentralized Wastewater Treatment	17	6	4	27
13. Integrated Water Resources Management	15	4	6	25
8. Safe Wastewater Use in Agriculture	12	4	7	23
2. Non-conventional Water Resources	12	6	3	21
1. Water Use Efficiency	7	8	3	18
11. Remediation and Rehabilitation of Water Bodies	12	0	5	17
12. Farm Water Management	7	6	4	17
4. Temperature Increase and Hydrological Changes	4	6	5	15
10. Industrial Wastewater Management	9	2	4	15
3. Vulnerability, Adaptation and Mitigation of Sea Level Rise	7	2	5	14
9. Integrated Aquaculture Systems	5	5	2	12
5. Transboundary River and Aquifer Management	8	0	2	10
15. Water Use Incentives	5	2	2	9
8. Increasing Fish Productivity per Unit Water	4	2	0	6
14. Irrigation Water Measurement	4	2	0	6

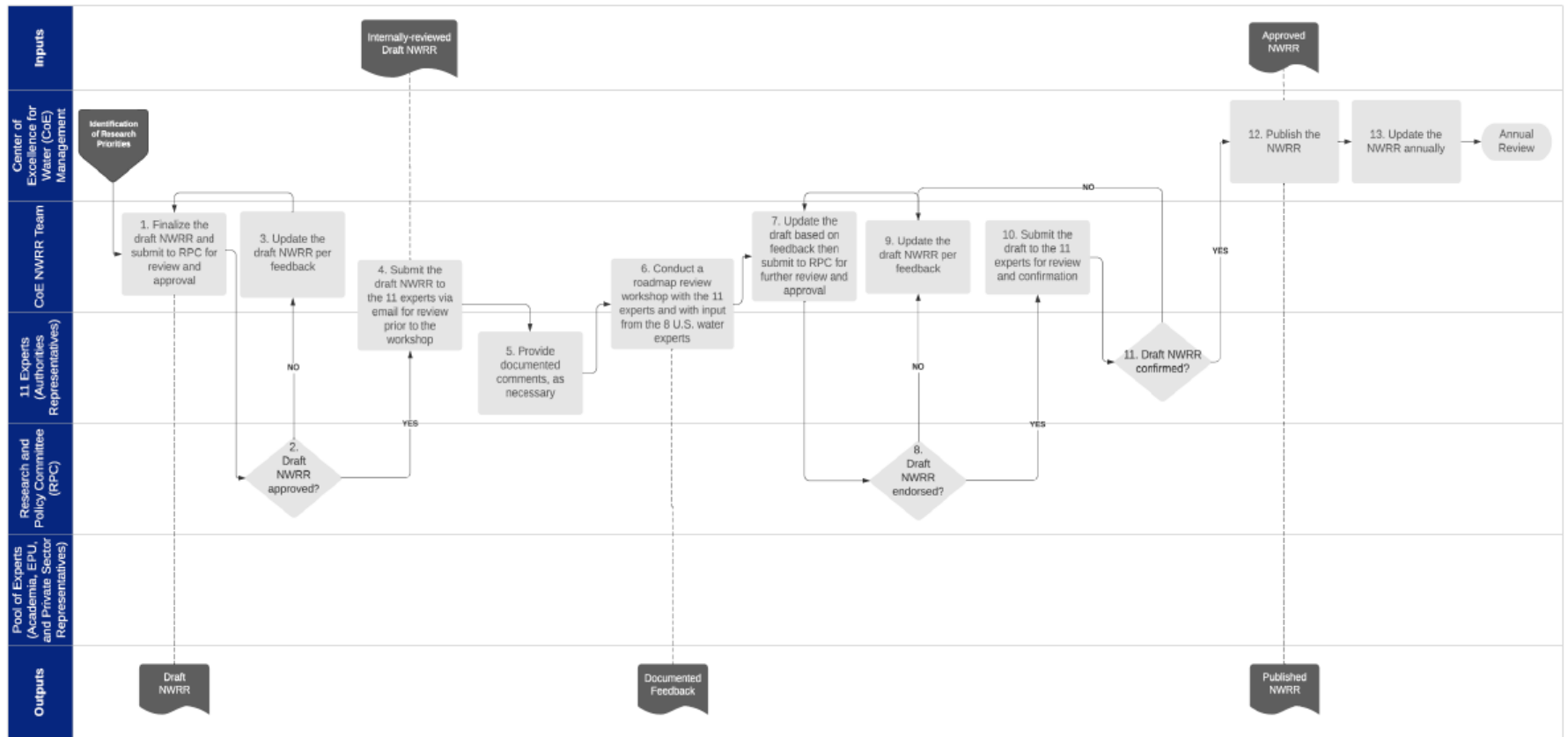
Assessment of the relative weight of each research topic with respect to Egypt's Social, Economic and Environmental conditions

Validation through Consultation on the NWRR


- Experts have been selected for the first round of formal consultation.
- A Workshop was conducted including zoom meetings with U.S. Experts.

Topics	COE-W	Expert1	Expert2	Expert3	Expert4	Expert5	Expert6	Expert7	Expert8
1. Water Use Efficiency	22	24	32	24	26	25	33	25	28
2. Non-conventional Water Resources	24	14	2	21	23	20	20	17	26
3. Vulnerability, Adaptation and Mitigation	8	9	4	11	24	16	10	4	16
4. Temperature Increase and Hydrological Changes	19	14	12	19	24	14	18	15	18
5. Transboundary River	6	5	6	17	27	17	14	7	18
6. Safe Treated Wastewater reuse	20	20	15	23	25	23	21	21	30
7. Centralized / Decentralized Wastewater Treatment	17	10	17	20	13	12	19	16	20
8. Increasing Fish Productivity per Unit Water	9	4	17	14	17	13	12	11	17
9. Integrated Aquaculture Systems	19	8	15	19	20	24	12	13	21
10. Industrial Wastewater Management	10	4	10	18	15	14	17	17	19
11. Remediation and Restoration of Water Bodies	14	7	22	29	18	24	15	23	27
12. Farm Water Management Irrigation Modernization	18	13	17	23	27	23	16	20	14
13. Integrated Water Resources Management	17	13	23	33	31	27	28	18	33
14. Water Allocation	10	9	18	14	27	19	15	19	29
15. Water Use Incentives	9	13	22	25	29	21	8	16	26


Relative weight (priority) for each topic as identified by the experts



Adopted methodology for the Consultation Process on the draft NWRR



Although no consensus on prioritization of topics was reached, however, the following list of 5 topics are to be considered the top five:

- 1. Water use Efficiency**
 - 2. Integrated Water resources Management**
 - 3. Safe Treated Wastewater reuse**
 - 4. Non-conventional Water Resources**
 - 5. Remediation and restoration of water bodies**
- 

Water Use Efficiency

- Increasing water use efficiency is a key research area towards “producing more with less.”
- This research area should include enhancing irrigation systems in Egypt and introducing new irrigated agriculture techniques.
- The focus of this research area will be mainly on agricultural, industrial, and domestic water use in Egypt.
- For example, in the Nile region, the focus should be on using modern irrigation techniques to enhance water use efficiency.
- In cities, the focus should be on identifying systemic inefficiencies such as pipe leaks and inefficient industrial or domestic devices.

Integrated Water Resources Management

- The development of the overall IWRM in Egypt is essential in the era of climate change and upper Nile challenges.
- How will water be managed in a more efficient way?
- How will non-conventional water be integrated to the equation?
- What will be the priorities in the future?

Safe treated wastewater reuse

- In the absence of full coverage of sewage system for these villages, there is a need for research that leads to innovative solutions for the challenge of rural wastewater disposal that enables safe water usage for agricultural purposes.
- Research is needed on methods and implementation for villages to provide adequate treatment of domestic sewage to make it safe to use for agricultural irrigation.

Non-conventional water resources

- Expanding the use of desalination of sea and brackish water
- Treatment and reuse of agricultural and sewage wastewater.
- Development of new technologies, (e.g., fog capturing, weather modification, and rainwater harvesting).
- Research into these technologies and the means of teaching end-users how to build, manage, and maintain systems could increase the use and cost effectiveness of non-conventional sources.

Remediation and Rehabilitation of Water Bodies

- Developing affordable local technologies for enhancing the water quality of open water bodies such as lakes and irrigation channels should be pursued.
- Research can help lower the cost of remediation and rehabilitation of water bodies.

The Second National Water Research Roadmap

Each topic is going to be studied in a general form following the same outline:

- The relationship between the topic and Egypt's water problems
- **Egypt's experience and risks related to the topic area.**
- Research in/about Egypt and the topic area.
- **The relationship between climate change and the topic area.**
- Opportunities to improve the topic area in Egypt.
- *What research is needed* for Egypt to improve the practices of the topic area.

Useful Links

- Facebook – Center of Excellence for Agriculture and Water
<https://www.facebook.com/share/151TVK3VBY/>
- First National Water Research RoadMap
<https://tinyurl.com/55ysry9>
- Second National Water Research RoadMap
<https://tinyurl.com/bdskpakb>



*Thank
you*