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Abstract: Water resource management in Al Jabal Al Akhdar region is very conventional and inefficient. This is mostly due to the absence of the stakeholders’ participation, the inflexibility of both laws and decisions-making in the water resources sector, and the ineffective administrative structure of the water institutions. This paper suggests a comprehensive reform of the water sector with applicable laws and the necessary regulations to achieve the sustainability of the water resources in Al Jabal Al Akhdar area and to meet the needs overlooking the expected population growth rate in the region.

1. Introduction

Libya is one of the driest countries in the world. The rainfall is very low more than 95% of the country receiving less than 100 mm annually. Rainfall occurs during the winter months, but great variability is observed in space and time (year to year). Population pressure and increased competition among different land users have highlighted the need for more effective water resources planning and policies. Rational and sustainable water use is an issue of great concern to the Libyan authorities and to water users interested in preserving water resources for the benefit of present and future generations.

Population growth is the primary factor driving increases in the demand for food and agricultural products. The Libyan National Authority of Documentation and Information indicated that the total population of Al-Jabal al-Akhdar area as 530,503 inhabitants in the year 2006. The future population in 2025 is expected to grow to 769,487 inhabitants in the year 2025. However; the majority of the population is settled in the coastal main cities in the area; Al Abyar, Al Bayda, Al Marj, Al Qubbah, Darnah, and Shahat while the rest live in 54 villages scattered across the region.

Al-Jabal Al-Akhdar (Green Mountain) area is a highland along the northern eastern of Libya as shown in Figure (1). It is a crescent-shaped ridge attaining a height of more than 850 m a.s.l. in its central part. The northern flank consists of step-like plateaus bordered by escarpments. The southern flank dips gently towards a depression extending from Ajdabiya to Al Jaghbub, which is marked by several large sabkhas. To the east and mostly to the west,
a coastal plain is well developed between the foot of the first escarpment and the sea (Pallas, 1978).

Figure (1) : Location Map (Hamad, 2012)

2. Current management

2.1 Water Legislation
There are numerous legislations related to water sector in Libya and also numbers of decree, both issued by the previous Ministerial Council, known as The General Peoples Committees. In Libya, there are five decrees related to water resources as summarized below:

- **Law no 106 (1973)** consists of 6 chapters, 141 articles, and implementation regulations governing public health. Water was mentioned in different articles regarding health protection in relation to water standards, water sampling, and water pollution.
- **Law no 112 (1973)** this law consists of 25 articles governing the regulations of the practice of drilling water wells.
- **Law no 3 (1982)** consists of 17 articles and implementation regulations where it declares the water as a partnership between the people and that all people are responsible for its protection and maintaining it from overuse. The main concerns and components of the law can be summarized as:
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1. Governing all of natural water resources.
2. Divided the country into water regions.
3. Regulate the uses of water.
4. Prohibits the discharge of waste and pollutants to the water resources.
5. Prohibits drilling water new wells without permits.
6. Prohibition of over-exploitation of groundwater in areas where the deterioration in the aquifers take place.
7. Regulate the exploitation of groundwater in oil industry.

- **Law no 7 (1982)** consists of eleven chapters and implementation regulations deals mainly with the environment and shows a great concern water resources protection.
- **Law no 9 (2003)** consists of three articles that mainly lifted and all constraints on groundwater exploitation by cancellation of all prohibits for drilling water wells without permits.

There were also several decrees (Table 1) had been made in a sudden manner and with no prior planning and had to be implemented immediately. This kind of actions shows the general phenomenon of the former regime and its unpredictable manner, although some of these decrees are considered crucial.

### Table (1): Decrees concerning water in Libya (GWA, 2009)

<table>
<thead>
<tr>
<th>Decree Number</th>
<th>Year</th>
<th>Declaration subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>85</td>
<td>1976</td>
<td>Conditions of exploitation of water resources form Al Marj basin</td>
</tr>
<tr>
<td>183</td>
<td>1976</td>
<td>Conditions of exploitation of water resources form Jafarah plain and surrounded mountain</td>
</tr>
<tr>
<td>452</td>
<td>1976</td>
<td>Conditions of exploitation of water resources form Komas and Musrtah first Aquifer</td>
</tr>
<tr>
<td>814</td>
<td>1979</td>
<td>Prohibits water drilling in Jafarah plain and surrounded mountain</td>
</tr>
<tr>
<td>798</td>
<td>1982</td>
<td>Implementation regulation of the Law no 3 1982</td>
</tr>
<tr>
<td>791</td>
<td>1982</td>
<td>Implementation regulation of the Law no 3 1982</td>
</tr>
<tr>
<td>94</td>
<td>1984</td>
<td>Modification regarding decision for drilling water wells permits and regulation of the Law no 3 1982</td>
</tr>
<tr>
<td>95</td>
<td>1984</td>
<td>Modification regarding decision for appointment of the Department of Water and Soil for drilling water wells permits and supervision</td>
</tr>
<tr>
<td>757</td>
<td>1990</td>
<td>Regulate general water authority</td>
</tr>
<tr>
<td>431</td>
<td>1994</td>
<td>Regulate the exploitation of water</td>
</tr>
<tr>
<td>82</td>
<td>2002</td>
<td>Detached the drilling water wells permits and supervision from General Water Authority to local departments of agricultural</td>
</tr>
<tr>
<td>625</td>
<td>2007</td>
<td>Cancellation of the Decree number 625 and prohibits water drilling in some regions in Libya</td>
</tr>
</tbody>
</table>
2.2 Water Pricing

Water is still considered as a free commodity in Libya. The farmers are not charged for water for irrigation, where they are only billed for the consumption of energy. City dwellers supplied with municipal water through public networks are charged for the water consumed based on a poorly operating metering system. The billing system is not in operation in most urban centers. Public utility departments, locally established in each district are still estimating the consumption as most water meters are not properly functioning and need to be replaced (WPS, 2011).

2.3 Water Institutions

The water institutions in Libya are established by the Ex-Ministerial Council, and in a very centralized approach. Operations are regulated through several laws including Water Law (3/1982), Public Health Law, and Law (15/2003). Complimentary Regulations and resolutions include those on land use management, agriculture, urban planning, infrastructures and utilities. National drinking water standards and effluent reuse/disposal criteria are also applied (Abufayed and Elkebir, 2010). These water institutions were characterized by less administrative stability, and overlaps in responsibilities always occurs. The main responsibilities and tasks of these institutions can be discussed according to (Abufayed and Elkebir, 2010; WPS, 2011; GCWW, 2012; GWA, 2012) as in the following:

1. The General Water Authority (GWA), formed in 1972 and is entrusted with:

   - Conducting studies and research to ensure optimum utilization of available resources;
   - Design and supervision of dam construction and follow up of their operation and maintenance;
   - Providing advice in connection with exploitation of water resources to general secretariats organizations and authorities;
   - Preparation of technical specification for drilling, completion and maintaining water wells and supervising their implementation;
   - Proposing the general water policy; and
   - Proposing water legislations.

   Additional tasks were later added to GWA to cover the fields of irrigation, drainage and soil. In 2006, GWA became under the general supervision of the General People’s Committee of Agriculture.

2. The General Company for Water and Wastewater (GCWW) was established in 1996 and was initially entrusted with the following main responsibilities:
• Operation and maintenance of transmission and distribution networks and water pumping stations and control centers and control the list, to ensure the provision of better services to the users of them;
• Operation and maintenance of drainage systems and related treatment plants, filtration, pumping and monitoring, control, and so as to ensure provision of better services to users of it;
• Carry out installation and connections for sanitation services to consumers;
• Carry out water supply for consumers and conducting studies on the development of consumer services, leading to the development of water services in all areas;
• Tax for the services of water and sanitation, according to the rules of the organization;
• Develop training plans for the development and human resource the relevant authorities and take action to implement the support of those programs and plans;
• The studies and technical and economic research relevant to transportation systems, water distribution and maintenance projects and construction of sanitation systems;
• Propose policies for water and sanitation and the rules necessary to regulate the activities including designed to develop and expand;
• Propose specifications and standards in the field of water and sanitation; and
• Propose Strategic plans long, medium and short term water and sanitation, and transmit them to the relevant authorities for approval.

4. The General Environmental Authority
This authority deals with for water resources quality and monitoring regulate the protection of environment.

5. The Man Made River Authority
This authority was established by law (11/ 1983) to deal with the implementation of the water extraction from aquifers in the southern region, to be transported to the coastal strip in the northern areas.

In addition to these main water institutions, there are some other ones with minor responsibilities in water resources are:

1. Agriculture Research center (ARC)
2. The National Center for Standards (NCS)
3. The General People's Committee for Utilities (GPCU)
4. The Housing and Infrastructures Board (HIB)
5. The Secretariat of Energy

Most of the previously discussed water institutions have their activities in Al Jabal Al Akhdar, mainly the GWA, GCWW, which are currently planned and financed centrally in the headquarters in Tripoli, and the branches in Benghazi, where the participation of the local stakeholders is very strict and with limited tasks. Table (2) illustrates the organizational
framework and infrastructure of GWA in East Libya. The structure results in the following water management issues:

- Inability to manage water resources for the entire area.
- Loss of water resources information, which is the bases of water resources assessment.
- All the information and technical studies existed at the branch in Benghazi. Logistical problems in overseeing the implementation of the facilities of water resources which led to deficiencies in performance.
- A centralized licensing and transactions on water resources has resulted in violations.

**Table 2: The organizational framework and infrastructure of GWA in east Libya.**

<table>
<thead>
<tr>
<th>Headquarter</th>
<th>Eastern branch</th>
<th>No of Employee</th>
<th>Labs</th>
<th>Offices</th>
<th>Information center</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Benghazi main office</td>
<td>42</td>
<td>1</td>
<td>Two floors building</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Al Marj</td>
<td>6</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Al Abyar</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Al Baydah</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Shahat</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Al Qubbah</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tripoli</td>
<td>Dernah</td>
<td>3</td>
<td>-</td>
<td>Small office</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Tobrock</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Al Jabal Al Akhdar</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The GCWW manages the day-to-day operation and maintenance activities according to an approved "central" national plan (and budget). The company delegates its mandates to its eight administrative units serving the different regions of Libya. In so doing, a reasonable degree of decentralization is practiced. Past experience with dissolution of the GCWW and total decentralization was only partially successful as the new regional "sub-authorities" lacked both the capacities to undertake their tasks and the experience to address problems with no central body to turn to for assistance and advice *(Abufayed and Elkebir, 2010)*.

**3. Future management**
3.1 Challenges and constraints

According to (Abufayed and Elkebir, 2010) and (Hamad, 2012) there is increasing water scarcity due to escalating demand driven by population growth and urbanization and uneven distribution of water resources and quality degradation, water resources management in the area faces many challenges and constraints, which are as follows:

1) **Institutional**
   - Centralization in planning and financing
   - Limited budget and financial resources
   - The overlap of water institutions
   - The lack of coordination between the water institutions
   - Organizational instability
   - Limited structuring between the functional levels
   - Inadequate institutional capacity at regional and local levels
   - Limited experience in integrated management
   - Less participations of the stakeholders

2) **Human**
   - Socio-economic dimensions are insufficiently reflected
   - Less in capacities in water management
   - Limitation in skilled labor and insufficiently prepared for coping with future challenges
   - Absence of an organized long-term approach to awareness raising activities
   - Lack of financial incentives to workers in water institutions

3) **Legislative**
   - Some laws conflicting with water resources conservations
   - The adoption of laws governing the protection of some water resources not associated with implementation procedures and no supplementary economic opportunities
   - Some of the decisions those made disposing of legal prerogatives to intervene in the scope of water.
   - The enforcement of water laws made by different parties in less integrated manner

4) **Technical and environmental**
   - Lack of Monitoring water resources
   - Lack and quality of data
   - Absence of proper specifications and technical procedures

3.2 Water legislation reform

Water laws and legislative instruments are essential and powerful tools for formulation and implementation of integrated water resources management IWRM plans. The legislation and regulation systems (e.g. laws, by-laws, rules, decrees, agreements, etc.) should deal with all
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water uses, monitoring of water quantity and quality, water allocation for various functions and sectors, water rights, etc.) (ESCWA, 2008).

The following key legal amendments should be considered to carry out the process of water legislation reform:

- The current water resources laws and legislative instruments for water resources in Al Jabal Al Akhdar area considered as part of the Libyan national laws and legislative instruments, and cannot be separated with consideration of some subdivisions form water laws should be customized based up on environmental situation of Al Jabal Al Khdar.
- Current water laws and regulations need to be updated for adoption IWRM policies and plans.
- Enabling the authority and empowerment to all the Water stakeholders by define their rights and responsibilities in the water laws.
- Activating the role of financial institutions, banks and economic organizations to support programs of sustainable development, with the active participation of the private sector and investors through a partnership between the public and private.
- Decentralization and monopoly removal in the field of water resources studies
- Initiate activation of economic instruments and effectiveness in the laws of water to provide the legal framework and support for policies such as cost recovery and water pricing
- Enable the provision of power to the inspectors and enforcement personnel in the institutions of water, health and the environment to play an active role, and to ensure compliance with the standards and regulation in the water laws in coordination with other enforcement authorities such as the Ministry of the Interior, and agencies of the national security and the water police.
- The involvement of lawyers and parliamentarians from the beginning of the process of developing policies and strategies to raise the water level of awareness and knowledge about the legal aspects and the necessary reforms to improve the management of the water sector.

3.3 Water institution reform

For many reasons, developing country governments consider water resources planning and management to be a central part of government responsibility. This view is consistent with the international consensus that promotes the concept of government as a facilitator and regulator, rather than an implementer of projects. The challenge is to reach mutual agreement about the level at which, in any specific instance, government responsibility should cease, or be partnered by autonomous water services management bodies and/or community-based organizations (Cap-Net, 2005). To establish a new implementation framework that includes a clear description of roles and functions of the organizations involved in the implementation process, time schedule, level of responsibilities and relation to other stakeholders, communication channels, and the reform for water institutions for Al Jabal Al Khdar should
be carried with respect to previous key legal amendments. The proposed organizational framework as in the figure (2) that illustrates all the stakeholders within the proposed framework where new proposed institution to function as a water law enforcement instrument, and the second proposed institution is Al Jabal Al Akhdar water council, aimed to:

- Secure financial budgets regarding water resources investment and conservation
- Act on the lowest provincial/local level
- Monitor and follow up the implementation of local action plans on the operational levels,
- Carry responsibilities of operation and maintenance of water resources infrastructure,
- Identify local issues and priorities that should be incorporated in regional and national plans,
- Resolve conflicts among water users at local level,
- Ensure decentralization
- Ensure water information system integrity and quality

![Figure (2): proposed organizational framework](image-url)
4. Conclusions

Water resources management system in Al Jabal Al Akhdar Area is very traditional and weak, and that is clear from the gaps, constraints, and challenges that have been reviewed in this research, which mostly due to the noninvolvement of local stakeholders and fluidity of laws and decisions on water resources and administrative structure for water institutions. Therefore need a comprehensive reform for water sector with applicable laws and regulations necessary for sustainability of the water resources of Al Jabal Al Akhdar and applying the principles of integrated water resources management principles.

5. References


