

The United Nations Development Programme

A close-up photograph of a young woman with a joyful expression, wearing a dark blue headscarf with red patterns and a red and orange patterned garment. Her arms are crossed in front of her, and she is looking directly at the camera.

A Holistic Approach to Addressing Water Resources Challenges in Yemen

UNDP Strategic Framework

November 2022

Water is not a commercial product like any other but, rather, a heritage which must be protected, defended, and treated as such.

Preamble to the European Union Water Framework Directive, 2000

Acknowledgments

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60th Metre Road
P.O. Box: 551 Sana'a, Republic of Yemen

<https://undp.org/yemen>

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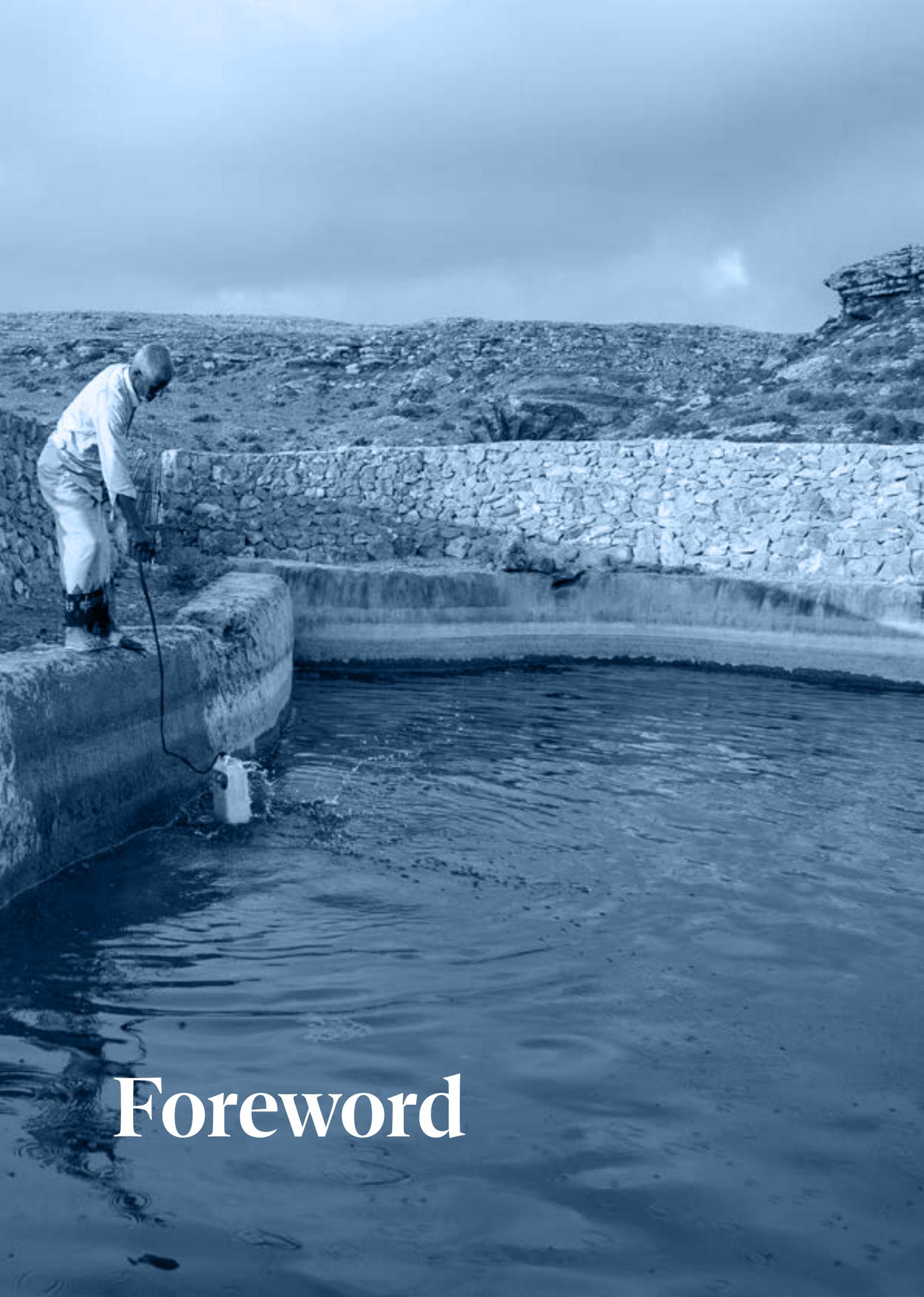
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Abbreviations and acronyms

BOQ	Bill of quantity
EPA	Environmental Protection Authority
FAO	Food and Agriculture Organisation of the United Nations
GARWSP	General Authority for Rural Water Supply Projects
GDP	Gross domestic product
IWRM	Integrated water resource management
JMP	Joint Monitoring Programme (UNICEF and WHO)
lpcd	Litres per capita per day
LWSC	Local Water and Sanitation Corporation
MAI	Ministry of Agriculture and Irrigation
mcm	Million cubic metres
MENA	Middle East and North Africa
MoPIC	Ministry of Planning and International Cooperation
MWE	Ministry of Water and Environment
NGO	Non-governmental organisation
NWRA	National Water Resources Authority
NWSSIP	National Water Sector Strategy and Investment Programme
RWSSP	Rural Water Supply and Sanitation Project
SDG	Sustainable Development Goal
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
WASH	Water Sanitation and Hygiene
WHO	World Health Organisation
WRM	Water resource management
WUA	Water user association
WUG	Water user group
WSSP	Water Sector Support Programme



Foreword

For years, Yemen has been living above its water means and is using its non-renewable groundwater at an unprecedented and irreplaceable pace. Today, approximately 84 per cent of Yemen's water is used for agriculture – 30 per cent of which is used for qat, a water intensive crop grown in northern Yemen where most of the population resides. This leaves a paltry 16 per cent of the water reserves for human consumption and industrial use.

Yemen will run out of water soon and, unfortunately, the reserves that took thousands of years to create have been largely depleted in the past 50 years.

The country is rapidly approaching a time when only renewable water resources such as rain, surface, and shallow groundwater will be the only options available for both human and agricultural use. But with one of the highest population growth rates in the world – and the extensive prevalence of high-water crops – the water supply will quickly fall short of the growing demand. It is clear that renewable water will be insufficient.

Yemen is on a crash course to face yet another overwhelming crisis if we do not act now.

Understanding this, UNDP worked closely with the Ministry of Water and Environment and the National

Water Resource Authority – as well as the authorities in the north and south – to develop a holistic water strategy. Aiming to help Yemen overcome some of the critical existing and upcoming water challenges, the strategy outlines an approach where water and food security, governance, and peace are interlinked and are fundamental components to achieving water security in Yemen.

Despite the humanitarian crisis due to the ongoing conflict, sustainable and integrated water management is both essential and urgent. But through swift action, strategic vision, commitment, and coordinated efforts, we can help ensure that we are not leaving Yemen behind and that they have the tools to avoid yet another crisis.

I would like to thank the Yemeni authorities and colleagues in the Ministry of Water and Environment and National Water Resource Authority for their support, cooperation, and inputs.

Auke Lootsma

Resident Representative

United Nations Development Programme (UNDP)
Yemen



Executive summary

Incredible as it may sound, Yemen is now experiencing its “water golden age”. In terms of water, Yemen is living well above its means. This is made possible by exploiting non-renewable groundwater. An inheritance created by nature over 10,000 years has been largely depleted over the past 50 years.¹

The country is rapidly approaching an era where only renewable water resources will be available. Such resources (rain, surface and shallow groundwater) fall at least one third short of present water demand. Those resources will have to be shared between agriculture and an ever-increasing demand for urban water supply. Given the extreme water scarcity in Yemen, fulfilment of Sustainable Development Goal 6, which ensures access to water and sanitation for all, will require considerable reallocation of water resources from agriculture.

The battle for rational and equitable use of non-renewable resources is lost: more can, and should, be done to ease the transition to a renewable-water-only world, and to minimise the human cost, conflicts, and inequalities deriving from it.

This is in a context where water usufruct rights are unclear, and the traditional rules unfit for purpose in the twenty-first century. The most problematic consequences of poorly defined water rights are inequitable distribution at the village level and conflicts of interest between agricultural users of water and urban water suppliers.

UNDP is implementing different projects for solutions to water problems in Yemen. They include Water, Sanitation and Hygiene (WASH), prevention of water-related conflict through joint projects with the Food and Agriculture Organisation (FAO), and promotion of coffee production to replace qat, so as to reduce water consumption in agriculture.

Under the joint project with FAO, “Resilience Programme in the Irrigation and Agricultural Sector”, funded by the German Development Bank, UNDP conducted a study, “Water availability in Yemen”, to map current and future water resources in Yemen based on available information. The study provided insights into water balances and recent trends, and revealed that the scarcity of groundwater is no longer negligible, and more comprehensive intervention with a new approach is needed.

Based on the evidence of the study and signs of the change toward peace, UNDP has developed this strategic framework for the water sector to respond

to challenges with a comprehensive approach utilising UNDP’s long-term experience and comparative advantage in the water sector.

Water and food security

Yemen will never be food self-sufficient. Yemen imports a quantity of ‘virtual water’ that is more than twice of the total of its renewable water resources. This does not mean that Yemen cannot be food secure: it means that food security for Yemen is primarily about open and fair access to markets.

Agriculture will continue to have a role in the country, and an important role in rural livelihoods: demand for fresh produce will always be there, and water-friendly cash-crop production will contribute to food security, strengthening supply chains and assuring purchasing power for rural communities. In terms of water management, the challenge will be to allocate the renewable water resources efficiently and fairly.

The first, indispensable, step is to develop and augment the renewable water infrastructure to efficiently capture renewable water resources – as well as sustainable groundwater – and make them available through surface irrigation and storage. Once developed, the renewable water resources must be allocated fairly and efficiently among all beneficiaries, starting with realistic water allocation planning that uses a bottom-up approach including irrigation techniques and cropping patterns.

Water user associations (WUAs) will be key to guaranteeing fairness in allocations, sustained maintenance of infrastructures, and decision-making mechanisms. The associations shoulder a great responsibility and need to be strong. They will be created, or reactivated, learning from past missteps, so that financial sustainability and effective contributions from all, especially women, are ensured.

Water and governance

The control of water rights will have an overwhelming effect on the future of agriculture, the life of rural communities, and water supply to the cities. In Yemen, whoever controls water controls the future.

The water law of 2002 respects the traditional right to benefit from the rain harvest and naturally flowing flood water (i.e., the renewable resources). While traditional rules regulated renewable water resources in Yemen for centuries, they are ill-suited to the needs of the twenty-first century, whether to regulate

1 Non-renewable resources include deep groundwater, while surface water and shallow groundwater will continue to be available, fed by the annual rains.

excess groundwater abstractions or to fairly allocate water into modern spate irrigation systems. Above all, both the Law and customary rules lack provisions on how to share water between agriculture and urban water supply.

As long as water rights are substantially negotiated at the village level, agreements can be promoted to that reflect the new reality and introduce a new consolidated practice. This, too, is deeply ingrained into Yemeni tradition: local water rules have always been highly diversified and adapted to the local context. The creation of new WUAs affords a perfect opportunity for negotiations between beneficiaries of water schemes to take place. The National Water Resources Authority (NWRA) has the mandate to include register such agreements in its register, but lacks written or consolidated guidelines on how to intervene, and the capacity to promote such guidelines or advise communities at scale. UNDP can support the development of guidelines on water rights and promote them to the international community as a gold standard, starting with donor-driven projects, adapting them as lessons learned, and providing a new institutional framework for the future.

Water and peace

Conflict is the most disruptive response to water scarcity. With increasing reports of conflict, water scarcity in Yemen is reaching the critical point where it might threaten social stability.

There are multiple drivers of conflict over water (see the Conflict analysis chapter, below). In extreme synthesis, they can be summarised as follows:

- Physical water scarcity, including appropriations from neighbouring farmers, villages or tribes.
- Insufficient capacity to pay for abstraction or maintenance of water schemes.
- Unfair water rules favouring particular landlords at the expense of others (classic upstream/downstream competition, and more recently competition for groundwater).
- Urban-rural competition for the same resource (and lack of a water rights blueprint to guide negotiations).
- Weak governance and capacity to enforce the rule of law.

The analysis in this work highlights how all the above drivers are likely to worsen as water availability declines and redistribution of renewable water resources becomes necessary.

Understandable, fair, equitable and enforceable water rights, especially concerning the distribution of water for urban and rural uses, can play a fundamental role in defusing some of the conflict drivers, but that will be only the beginning.

Community-based dispute resolution can decrease the risk of water-related violence. However, the challenges in empowering, sustaining, and maintaining the necessary structures are significant. WUAs can be the focus for defusing some of the tensions before violence breaks out, and can have key roles in supporting both central water law and traditional water rules, norms and laws. Disputes will likely arise unless rules and traditional agreements are adapted to the new situation. This should be discussed during planning phases and at the outset of community consultation and implementation. Consultation will involve sitting with key stakeholders, including downstream, upstream, and beneficiary male and female farmers to discuss changes. Properly capacitating community champions or “insiders” can be a key solution to peaceful water use.

Keeping wider communities informed and engaged – beneficiaries, neighbours who will not benefit, upstream communities and, most importantly, downstream communities – will be important in reducing disputes and disgruntlement within communities and districts or among districts.

To reduce dissatisfaction with any future work carried out, it will be important to be explicit about what the infrastructure will be able to achieve in terms of capacity, scope, and maintenance needs.

This strategy comprises three pillars, mirroring the UNDP practices in the Yemen office. They are: (a) Water and Food Security; (b) Water and Governance; and (c) Water and Peace. However, water resources management is inherently a cross-cutting topic, with technical, social, economic, and legal ramifications. No water system is viable without proper design, implementation, technical and financial management, and clear ownership in an enabling environment where benefits are equitably shared, the rule of law is respected, and drivers of conflict are mitigated.

Implementation of the strategy will require a holistic approach where all the elements discussed in this strategy are recognised as fundamental to achieving its objective. This will probably entail flexibility in the redistribution of resources among the three pillars, and an overall thematic coordination between the practices.



Introduction

Yemen has always been one of the most water-stressed countries in the world and the most water-scarce Arab country. Now, due to the compounded effect of climatic conditions, long-term water mismanagement, conflict, and explosive population growth, the country's water crisis is rapidly deteriorating and is headed towards a potentially catastrophic collapse.

UNDP is implementing various projects for solutions to water problems in Yemen. These projects include UNICEF's Water, Sanitation and Hygiene (WASH) Strategy, joint water-related conflict prevention projects with FAO, and the promotion of coffee production to replace qat so as to reduce water consumption in agriculture.

Under the joint Resilience Programme in the Irrigation and Agricultural Sector with FAO, funded by the German Development Bank, UNDP conducted a study, "Water availability in Yemen", to map its current and future water resources based on available information. The study provided insights into water balances and recent trends and revealed that groundwater scarcity is no longer negligible, and more

comprehensive intervention with a new approach is required.

The lasting war and humanitarian crises have affected not only water consumption patterns but also donor support. Support in the water sector focuses mainly on WASH intervention to ensure potable water in populated areas. WASH intervention will remain most important in the sector until the population have sufficient access to safe water. Meanwhile, the security and political situation in Yemen has vastly improved since implementation of the two-month truce facilitated by the Office of the Special Envoy for the Secretary-General in Yemen (OSESFY), followed by a further two-month extension. This brief moment of peace affords an opportunity for stakeholders in the water sector to think about long-term solutions with a comprehensive approach.

Based on the study and the move toward peace, UNDP developed this strategic framework for the water sector to respond to challenges with a comprehensive approach by utilising UNDP's long-term experience and comparative advantage in the water sector.



Water resources in Yemen – Evidence

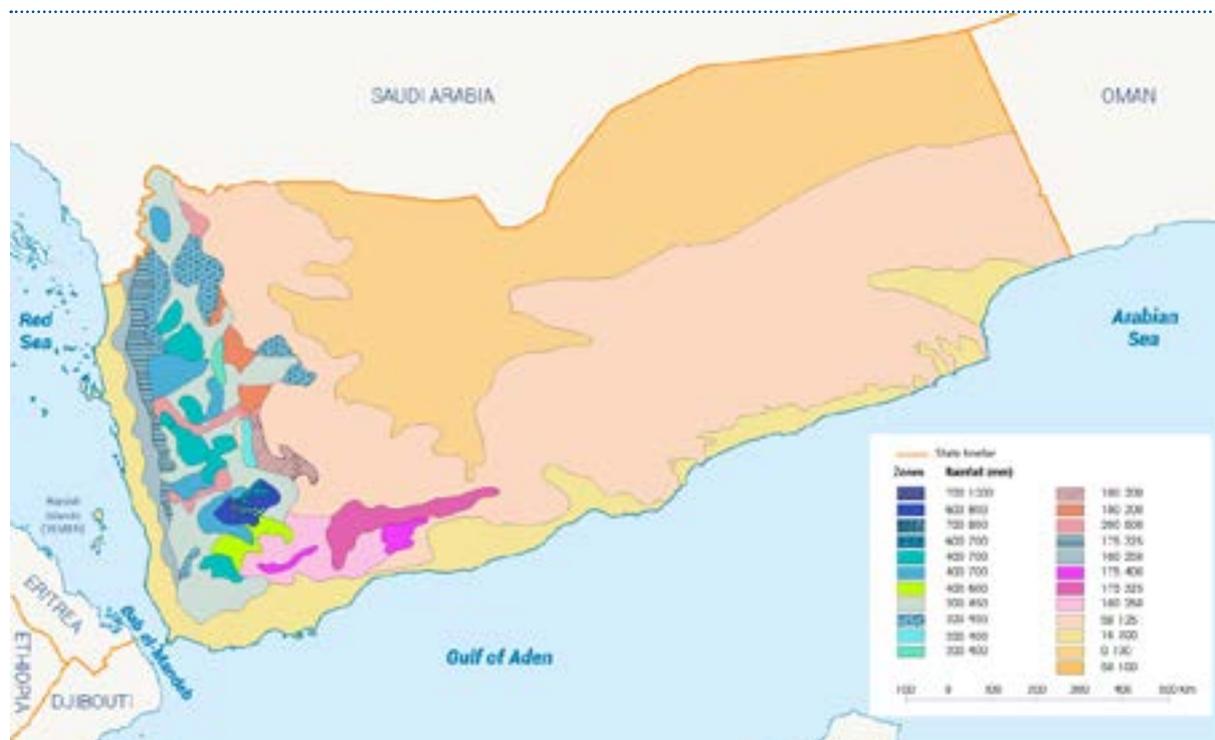
This chapter relies heavily on the recent study “Water Availability in Yemen” compiled by the Acacia Water Consultancy and published by UNDP in 2021.

Yemen is physically water scarce due to its limited rainfall and geographic location, with no shared international rivers.

The **annual water demand** for domestic and industrial use and agricultural consumption far exceeds

estimates of the annual renewable resource. The rate of groundwater overdraft, estimated to be more than twice the recharge rate and rising, is causing depletion of water reserves, increased inequities, and shortages, all with negative socioeconomic consequences. At the present rate, all groundwater sources in Yemen could be exhausted in less than 20 years (UNDP and FAO, 2020).

Figure 1. Rainfall map of Yemen



Source: Noaman et al., 2021

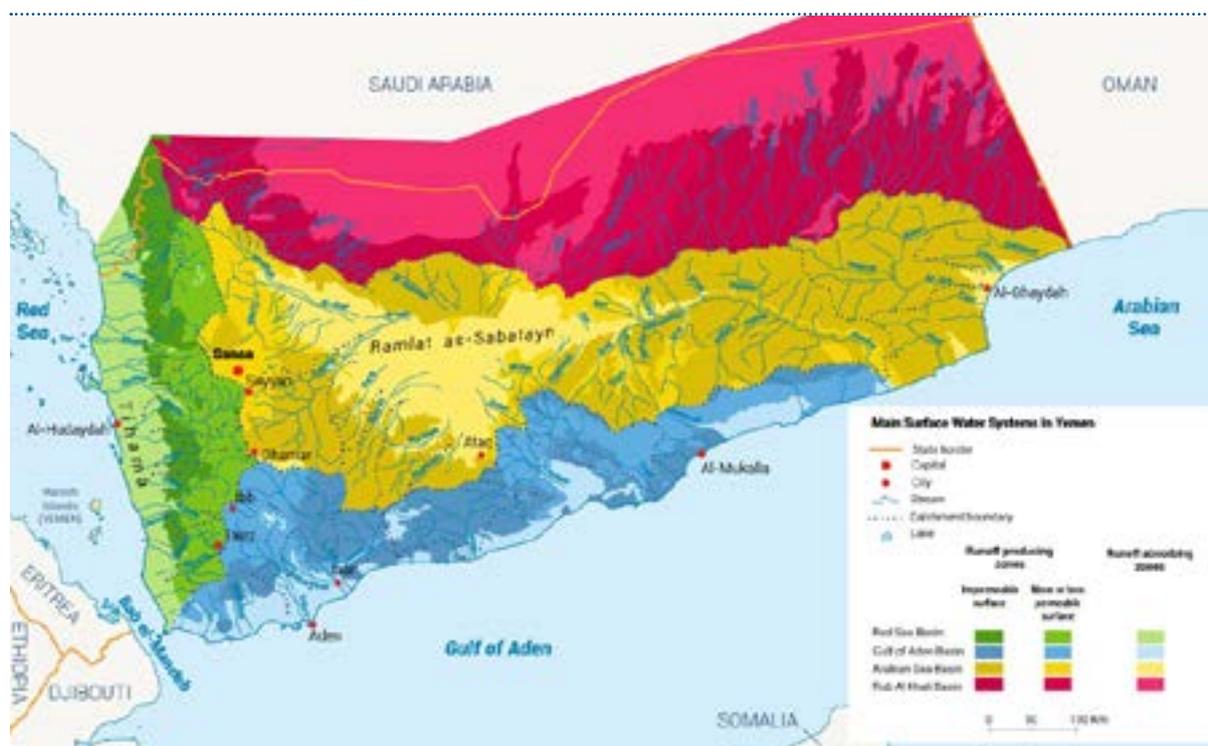
Two thirds of the country is classified as hyper-arid, with less than 50 mm rainfall per year, and most of the remainder is classified as arid, with less than 200 mm rainfall. Average rainfall above 250 mm is found only in the mountainous west-ern regions, where most of the population is concentrated, with some areas receiving more than 800 mm.

Across the country, annual rain volume varies from 67,000 mcm to 93,000 mcm (FAO AQUASTAT, 2008). In most areas, evapotranspiration far exceeds rainfall during the larger part of the year, and the rainfall is insufficient for rain-fed agriculture. Only the mountainous areas receive significant rainfall, providing water resources for agricultural areas either through spate flows or through pumping from groundwater for irrigation.

Surface water basins

The annual water demand for domestic and industrial use and agricultural consumption is estimated at 3,900 mcm/y (Noaman et al., 2021), which far exceeds estimates on the annual renewable resource – from both surface water (1,000 mcm/y) and groundwater (1,500 mcm/y) – of 2,500 mcm/y (Hellegers et al., 2008). The rate of groundwater overdraft, estimated to be more than twice the recharge rate and rising, is causing depletion of water reserves, increased inequities, and shortages, all with negative socioeconomic consequences. Some major aquifers are being depleted even more rapidly than before the start of hostilities. At the present rate, all groundwater sources in Yemen could be exhausted in less than 20 years (UNDP and FAO, 2020).

Figure 2. Water basins



Source: Noaman et al., 2021

The Red Sea Basin

A number of large wadis drain the steep western escarpment and lose most of their water in the permeable sediments of coastal Tihama. Rainfall in the highlands in spring and summer generates significant run-off in the upper and middle catchment.

In the coastal plain, some of the wadi flow diverted for spate irrigation is lost to evapotranspiration, some percolates below the soil profile into the aquifer and recharges groundwater, and some reaches the sea, generally by groundwater outflow. This is Yemen's most important basin, contributing 36 per cent of total run-off (World Bank, 2010).

The Gulf of Aden Basin

The main wadis drain south from the southern highlands. The large spate flows are extensively diverted in the broad coastal plain, but a larger share of flows still reaches the sea than is the case with the Red Sea Basin. Spate flows have dwindled due to continuing diversion upstream (World Bank, 2010).

The Arabian Sea Basin

Its topography would allow water to flow from the eastern slopes of the highlands down through the Ramlat As-Sabatayn to Wadi Hadhramaut, and out towards the sea via Wadi Masila. However, as rainfall rates are low and much of the soil allows for rapid recharge, the “basin” is more a series of discontinuous segments. Run-off volumes can be large, as witnessed during the flooding of 2008 in Wadi Hadhramaut, which caused a large number of fatalities and substantial economic damage to property and agriculture in the region (World Bank, 2010).

The Rub al Khali Basin

Water from the northern and north-eastern slopes of the highlands drains into the sands of the Empty

Quarter, where it infiltrates into groundwater (World Bank, 2010).

The mountain basins

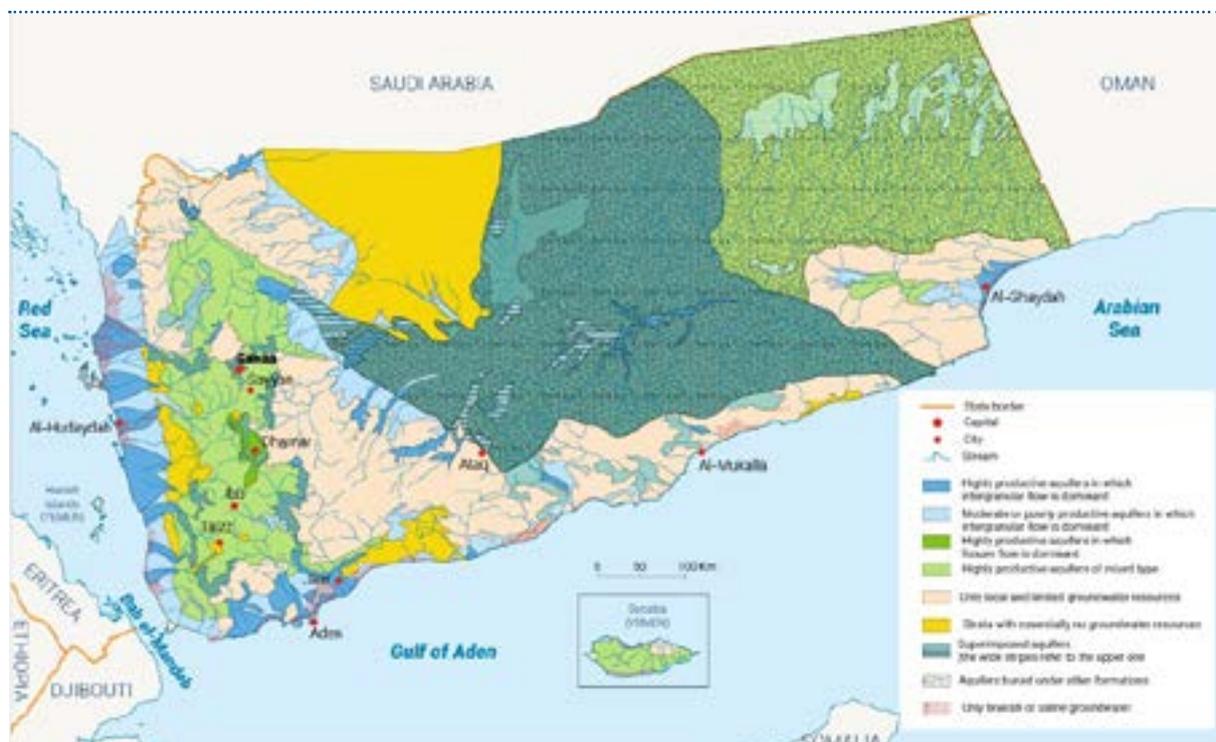
Scattered through the highlands, a series of plains surrounded by mountains constitute self-contained basins, with little or no surface water draining outside the basin. The recharge of groundwater in these small basins is limited, but they are centres of high population concentration and thus of heavy water use (World Bank, 2010).

Aquifer systems

Alluvial aquifers, formed in wadi beds throughout the country, are the most common kind of aquifers in Yemen; they consist mainly of sand, gravel, and unconsolidated deposits of sandstone, limestone and volcanic formations.

Solid rock aquifers of sandstone and limestone tend to be deeper and much more extensive. Most productive are the deep sandstone aquifers – sedimentary rocks with porous characteristics that allow water to seep through (World Bank, 2010).

Figure 3. Main groundwater aquifers



Source: Noaman et al., 2021

Quaternary aquifers

Wadi aquifers

Alluvial deposits in wadi valley bottoms constitute aquifers of limited dimensions. They are the most convenient sources of shallow subsurface water and, until recently, groundwater abstraction in Yemen was largely confined to this type of aquifer.

Due to their small volume and relatively high permeability, they can be depleted during prolonged dry periods.

Plains, alluvial fans and deltas

Plains, alluvial fans and deltas are usually situated in the alluvial plain of larger wadis. They are actively recharged by these wadis, and are normally larger than Wadi aquifers. The most important are the Tihama and the southern coastal plains (including the Abyan Delta), those at the western and southern edges of the Ramlat As-Sabatayn, and Wadi Hadhramaut.

Highland plains aquifers

The highland plains are scattered over the Yemen mountain massif. Most of them are located relatively

near to the main water divide that separates the Red Sea Basin from the other three drainage basins of the mainland. Many of the plains constitute small but relatively favourable areas for groundwater development.

The most important highland groundwater basins from north to south are: the Sadah Basin, the Amran Basin, the Sana'a Basin, the Ma'bar-Dhamar Plains Basin, and the Rada Basin.

Regional aquifers

Mukalla sandstone aquifer

Mukalla sandstone, averaging 300-400 m in thickness, forms a continuous regional aquifer of large lateral extent. This basin extends far northwards over the platform zone of the Arabian Peninsula.

The Mukalla sandstone aquifer constitutes the largest groundwater system in Yemen. Mukalla sandstones generally have high porosity and transmissivity. The sandstone is in direct hydraulic contact with the overlying Quaternary deposits in the Ramlat As-Sabatayn desert and, as a consequence, the two aquifers (Quaternary and Mukalla) form only one aquifer in this area. Through the use of environmental

Aquifers and data reliability

This paper contains lots of hypotheticals: “probably”, “most likely”. What does this mean? Is there any chance that all those estimations are incorrect, and that Yemen can count on present water abstractions forever?

No.

The hypotheticals come from the fact that aquifers are underground, and invisible. Think at aquifers as permeable “bags”, of natural soil or rock that contains water in the pores and fractures. They are not “underground lakes”, nor, as some diagrams imply, horizontal, uniform slabs of material with known characteristics.

Like rivers, they are separated in different basins. However, underground basins do not always match with surface basins, and some deep aquifers span between different basins. Moreover wells, when poorly constructed, put different aquifers into artificial contact. Aquifers are messy, and hidden. Some are just ‘a local affair’; others are regional.

Hydrogeologists learn about aquifers only from indirect sources such as drilling logs, water levels, pumping tests, water quality analysis, geophysical investigation and – more recently – remote sensing from space. The quality of all those data is very variable: trusting a drilling log is like trusting the verbal description of a Picasso painting.

On the one hand, we will never have sufficient data; on the other, more data is not always useful: poor data is just additional noise. sources concur on the fact that groundwater consumption in Yemen is much higher than its sustainable renewal rate.

isotopic indicators, it has been conclusively proven that the last major replenishment of the principal aquifers in many of today's more arid regions occurred in humid climatic episodes in the Holocene and Pleistocene eras.

Water resource monitoring

Established under presidential decree 154/1995, the NWRA is responsible for water resource planning and monitoring, legislation, and public awareness. However, most of the data collection and the information systems were scattered among water resources, supply and sanitation and irrigation projects in autonomous agencies. There were weak coordinated efforts and projects by different support agencies.

Groundwater monitoring work was focused on four project areas: the Amran Basin (1607 km²) northwest of Sana'a; the Ibb Basin (775 km²) in the southern highlands; and the two project areas located in the

southern coastal plain on the Gulf of Aden, the Wadi Tuban (535 km²) and the Abyan Delta (750 km²).

The multiple crises in the country set back the efforts of government and development partners to establish a monitoring system, leading to a major information gap and the following challenges:

- The data is incomplete and of low quality. Due to the unstable political situation, only a few groundwater monitoring works have been carried out since January 2011.
- The data still exist among several agencies in variable formats.
- Most of the information is estimated and predicted for each agency's purposes.
- Low investment in water resources management.
- Lack of sufficient, efficient human resources.
- Poor coordination among actors.



Legal framework

Customary water rules

Over millennia, every community in Yemen has evolved rules for water management. Archaeology attests to rules for spate management in the pre-Islamic period that are recognisable today. Some water rules of today were documented in medieval times. Historically (though much less so today), religious authorities were important in setting rules and resolving disputes. Some Shari'a principles affecting water are generally accepted throughout Yemen:

- Water is mubah, or “the property of no one.” However, the usufruct can be appropriated by those who develop it.
- Priority is for upstream riparian: al ‘ala fa al ‘ala.
- Water may not be alienated from the land.
- Wells must be spaced a certain distance apart, outside a “protection zone,” or harim (rule 58 in the Document of Seventy Rules).
- No one can deny a person drinking water – “the right of thirst.”

Spate irrigation

The fundamental sequence rule, locally called al ‘ala fa al ‘ala, grants an absolute priority right to upstream farmers regardless of the size of the flow. Downstream farmers are not, however, denied the right to surplus water. This rule might seem very unfair to the downstream farmers, but in older times, when diversion structures were constructed with traditional materials and techniques, they were frequently washed away, delivering abundant water downstream. Then modern structural modernisations replaced the indigenous structures with concrete weirs, which are seldom breached. This resulted in almost complete control of floodwater by the upstream users (starting even before the advent of well drilling), who used surplus water for cash crops such as bananas, further reducing the amount of water that reached

downstream fields. The ultimate consequence is that many of the downstream fields are now abandoned.

Demarcation rights and rules are common in the lowland, spate-irrigated areas where water is scarce and land is abundant. Demarcation rights and rules define the boundary of the area entitled to irrigation and set priorities for water access depending on the year of establishment of the respective fields. The prior rights of downstream landowners are often protected by restricting or even prohibiting new land development upstream, which could otherwise have resulted in the diversion of floodwater to new territories and a redefinition of the group of shareholders.

There are also rules covering depth of irrigation, second turns of irrigation, and large and small floods.

The enforcement of water rights and rules in many spate systems had been the responsibility of the local ‘Sheikhs al-wadis’ appointed by the local ‘Sultans’. These ‘Sheikhs’ and ‘Sultans’ always belonged to the largest and most powerful tribe. Their leadership was passed on a hierarchical basis to the eldest son, with no provision for female heirs.

The Sultans and Sheikhs were not able to prevent conflicts over water, but were often successful in resolving them.

The links between water rights and rules, and the organisation and execution of maintenance tasks can be divided into three categories:

1. The right to floodwater is one’s contribution to the maintenance of main and branch canals and structures. If a farmer fails to contribute, he cannot be allowed to irrigate his field.
2. Tail-end farmers were only interested in sharing the burden of maintenance if they were not systematically deprived of their water right, which made ‘the critical mass factor’ a vital check on too large an inequity in water-sharing. Again, the introduction of mechanisation made this

aspect less relevant, further weakening the rights of downstream farmers.

3. The rules on demarcation help to identify the group of farmers entitled to floodwater who have an interest in jointly undertaking the necessary maintenance. Without the demarcation rules, it would be very difficult to form a group of partners, making the organisation and cost-sharing of maintenance work problematic.

Since the unification of Yemen and the creation of the national state, and even more after implementation of the water law, national institutions were supposed to replace the tribal system. Such institutions, however, always had difficulty handling the task alone. The main problem was poorly defined sharing of responsibilities and long communication lines; inadequate funding; and minimal accountability towards the bulk of users.

Springs and run-off rights

In springs, which have more stable flows, rights are normally attached to the land. The rights are denominated in time-shares (for example, a certain number of hours once per fortnight), and can be exchanged with other users to suit farming needs. Water distribution is overseen by local irrigation supervisors, not sheikhs – although sheikhs rule in disputes.

Run-off rights are assigned from specific slopes to parcels of bottom land in a proportion – sometimes up to 20 times the area of bottomland – adequate to grow a crop on the run-on land.²

Groundwater and wells

Every landowner has the right to abstract groundwater by digging under owned land. While there are some traditional rules covering access – for example, Harim well-spacing rules – no traditional rules exist for quantities extracted or water charges. In parts of northern Yemen, shared wells are common. Each group of irrigators works out its own rules for sharing capital and operating costs and for taking water turns—usually as a time-share.

Such rules, which envisage water as a finite, immobile resource to be mined, are inadequate to regulate the use of groundwater effectively and fairly. First, the aquifers tapped by wells are limited neither to the property boundary nor, often, to the surface hydrological catchments. Second, aquifers are not static, and water flows into them, with water entering and leaving the borders set on the surface. Third, different aquifers, each with its own characteristics, can be found at different depths in a well. Finally, and most importantly for WRM, the Harim rule (like any other rule limiting interference between wells) is focused on the performance of individual wells but does nothing to regulate the quantity of water abstracted from the common aquifer.

Water sales

Rules governing water sales are unclear. In principle, water is a common good, and as such cannot be owned, or sold. However, rights to the use of water, either for agriculture or domestic use, can be traded. In some localities, water sales between farmers are common. In others, water may be sold to outsiders and become a business.

Water law no. 33, 2002, and by-law

The water law, enacted in 2002, and its executive by-law in 2009, aim to regulate, develop and rationalise the exploitation of water resources. They are considered crucial instruments to reverse existing patterns of water use. The law gives detailed provisions for: (a) water resources management and planning; (b) water use; (c) water rights and permits; (d) water conservation and protection from pollution; (e) protection from floods and rainwater run-off; and (f) enforcement procedures and penalties.³

The water law is considered a tool that supports the Government in reaching its goals (mentioned in article 3 of the law). It also supports responsible water authorities in finding and solving water problems by taking the appropriate decisions in organising, managing, developing, and conserving water resources from exploitation and pollution. This includes suitable and effective methods for achieving integrated water resources management through a participatory approach.

² These run-off rights are very important. It is claimed that in Sa'adah houses have no cisterns for domestic water because they would infringe the run-off rights of others (Lichtenthaler 2003).

³ Many wells near cities, including Taiz and Sana'a (which gets two-thirds of its water from private wells), have been wholly or partly converted to urban water supply for profit.

In terms of water rights, the law respects the traditional right to benefit from the rain harvest and naturally flowing flood water “over the waters of springs, gorges, natural streams, and shallow wells whose depth does not exceed sixty metres” (art. 28), “except for the utmost necessity and with fair compensation” (art. 27) and “without prejudice to the rules of registration” (art. 30).

The owners of “groundwater wells drilled before the issuance of the law, and the owners of the usufruct rights attached, must apply to the NWRA or one of its branches within 3 years” (that is, 2005) (art. 33), and the NRWA keeps a register (art. 34), but the registry was never activated.

Dispute settlement

There are two systems for conflict settlement: a judiciary one and an arbitration one. The judicial system is based on the Law of Judicial Power, 1990, which stipulates that “courts are the judicial entities responsible for rulings in every litigation or crime...”. The court system comprises three levels of courts: the Supreme Court, appeals courts, and primary courts. The arbitration system comprises two types: legal arbitration, and custom (tribal) arbitration. The former follows the judiciary system and can produce out-of-court settlements. The latter is commonly used in rural areas to resolve water rights disputes. There are usually several levels of arbitration in this system, beginning at the village level and ending at the level of the tribe’s “Sheikh of Sheikhs”. These systems can be also applied enforcing the water law.

According to current practice, these disputes are first brought before the village aqil, and if he does not succeed in resolving them, they are submitted either to the sheikh responsible for the area, or directly to the courts. Although traditional aqils and area sheikhs have the authority to enforce water rights and settle

disputes among water users, that authority is often exercised to satisfy the interests of influential users, with the result that fights are common. The ordinary courts do not have the capacity to examine cases related to water rights, and judicial proceedings before these courts are normally lengthy.

Tribes and sheikhs

Tribes and their subdivisions are the primary social organisations in rural Yemen. Social organisations remain heavily tribal, and sheikhs (traditional authorities) continue to play a major role in the governance of rural areas. For each tribe, there are four hierarchical levels of sheikhs: the Sheikh M’Sheikh (highest ranking, and literally “sheikh of all sheikhs”), Sheikh D’mān (covering a district-level area or more), the Sheikh (sub-district level), and the Sheikh Mahal (also known as the Sheikh lohma or aqil, who operates at the hamlet level). The boundaries of the sheikhs’ territories do not always correspond to administrative divisions. Rural sheikhs play an important role in redistributing goods and services and settling conflicts. Their primary responsibility is to resolve disputes, manage communal assets, protect the weak, and collect and redistribute agricultural taxes. Islamic law (shari’a) and customary laws (urf’) provide the rules by which conflict and cooperation is mediated within or across tribes. Sheikhs play a convening role both in mobilising the community for collective purposes and serving as community interlocutors, lobbying local and central government for development projects. Sheikhs are nominated by their communities but have to be formally confirmed by the Government.

The state incorporates traditional authorities into formal state institutions through official recognition of some tribal leaders by the Department of Tribal Affairs in the Ministry of Interior, appointing them to high government office and including them in elections

to local government or Parliament, making them key actors in the state patronage system. The fact that sheikhs now draw on formal state systems to support them has weakened the traditional sanctions open to local people for holding them accountable or removing them. Well-organised tribes are still capable of removing their leaders, but for the most part their wealth and connections to the central Government are powerful sources of patronage. Because communities rely increasingly on their sheikhs to mediate with the central Government, they tend to voice little opposition to their patrons except in cases of gross infractions.

De-facto situation, May 2022

The political differences between the northern and southern parts of the country did not change any legal issues related to water resources management. Both

parts still respect the relevant laws and regulations and are working accordingly. But the ongoing local political and military conflicts that occurred since 2015 between various parties in northern and southern Yemen severely and negatively affected the operational status and capacity of most of the water sectors working there. They have had a great impact on most of the water activities, particularly enforcement of the water law and its by-law, and related water regulations. The water resources activities that are still operational are very limited. In order to recover and return to normal operational standards, water institutions will need adequate external investments and support in various areas, particularly institutional strengthening, information management, training and recruiting more qualified staff, and infrastructure development.



Integrated water resources management

Integrated water resources management (IWRM) is a cross-sectoral policy approach designed to replace the traditional, fragmented sectoral approach to water resources and their management that has led to poor services and unsustainable resource use. IWRM is based on the understanding that water resources are an integral component of the ecosystem, a natural resource, and a social and economic good.

The basis of IWRM is that the many different uses of finite water resources are interdependent. High irrigation demands and polluted drainage flows from agriculture, for example, mean less fresh water for drinking or industrial use.

This chapter will explore both the demand and resources balance and the social implications of present and future consumption patterns.

Socially sustainable plans

The objective of water resource management is to generate socially sustainable plans for achieving equilibrium between water demand (for domestic, industrial and agricultural uses, as well as healthy natural ecosystems) and water resources, both renewable and non-renewable.

Social sustainability contemplates the consideration of society's needs and goals, which will vary with time, place, and people. The changing nature of social sustainability and the interrelated risk of resource degradation are critical considerations when developing plans for the use of non-renewable groundwater resources.

A socially sustainable plan for use of the resource would therefore need to be formulated to meet three main conditions (Borrini-Feyerabend, 1997):

- Maintaining (or improving) the well-being of communities involved by meeting as far as possible their social, economic, cultural and environmental needs, now and in the future.
- Managing the actions of concerned individuals or communities that affect resource use, by strengthening their capacity to cooperate in the management of the resource and assuring appropriate financial, legal, technical, institutional and political conditions for adherence to the established management plan, maintaining intergenerational equity in terms of the benefits derived from the resource, and ensuring economic and social opportunities to all stakeholder groups, including future generations.
- An appropriate 'exit strategy' needs to be identified, developed, and implemented by the time the aquifer is substantially depleted, which would normally imply that society will have used the mined groundwater to advance economically, socially, and technically so as to enable future generations to develop substitute water sources at a tolerable capital and operational cost.

The objectives of IWRM plans go beyond achieving equilibrium between water supply and consumption. For IWRM plans to be sustainable in the long run, they need both to address the ownership of the water and to establish equity and equality in the distribution of costs and benefits stemming from the exploitation of water.

The situation of women in Yemen

In a highly patriarchal society, women in Yemen have historically been placed at a disadvantage due to their sex. Although the Government has made efforts to improve the rights of women, many cultural and religious norms, together with poor enforcement of the legislation, have prevented Yemeni women from having the same rights as men.

In the traditional agricultural economy, women sow, weed, harvest and process grain. Their active role in agricultural production used to provide them with significant economic power, physical mobility and voice within the household and community. However, as males increasingly migrate in search of wage employment, the household-based system of subsistence production is declining. Women who are left behind continue to work on land that has become more marginal because terraces are collapsing due to the lack of male labour. Thus, when women work on land that belongs to the household, it is increasingly on a subsistence basis (World Bank, 2008).

Women and girls in rural areas often collect water from far distances, exposing themselves to sexual harassment and to drowning in open-water reservoirs. For girls, this means less time is left for school attendance, while for women, less time is available for earning an income or taking care of their own and their families' health. With access to water becoming ever more difficult, the many additional hours women and girls now spend providing water for their households increases their deprivation of basic education, adequate health services, food security and personal development, and poses a risk to their physical safety.

The shari'a law on inheritance provides that daughters inherit shares in the decedent's estate, though smaller shares than their brothers'. But these rights are sometimes unrealised. By custom, women exchange their rights to land ownership for lifelong support and economic security from their male kin, or by laying claims to moveable property. The key point here is that the right to inherit is not a right to inherit land, just a portion of the estate. As in many Islamic societies, women's inheritance is largely limited to personal property.

Excluding women from land ownership,⁴ and hence from owning wells, and excluding them from decision-making processes, limit their control over water resources and livelihoods and deprives them of equal access to water as a basic human right (Bilkis, 2018).

Despite attempts made by local, national and international actors to improve equitable access to water and sanitation services, women are almost invisible when it comes to decision- and policymaking regarding vital water resources. Developing and implementing an inclusive and gender-sensitive approach to sustainable water management should therefore be one of the first priorities in Yemen.

Gender mainstreaming in the public water sector

The Yemeni water law (33/2002) is gender-neutral and does not consider the differing needs of women and men, boys and girls. It was drafted by an all-male committee. In 2004, a number of women were involved when the MWE, in collaboration with the Ministry of Agriculture and Irrigation (MAI), issued the National Water Sector Strategy and Investment Programme (NWSSIP, 2004-2009) to reorganise the water sector. However, the input of the handful of women in the five NWSSIP working groups is barely visible and is limited to addressing hygiene education and domestic water management in the rural water supply section.

Across all the governorates, not a single woman heads any of the water utilities or branches. Water resource management is usually seen as a male profession – a technical job requiring the expertise of engineers and technicians. In the past, there were very few female secondary school graduates. Despite improvement in the situation, with more having backgrounds in geology, civil engineering, and other technical professions, positions for women remain restricted to lower- and mid-level jobs, while men are more likely to hold higher positions.

Women are not sufficiently represented in local councils or local water-basin committees. For socio-cultural reasons, women still face many challenges when trying to attain higher management positions.

Even when an institutional role is carved out for women, they have problems making themselves heard. "We are not prepared to raise our voices in

4 Women are not limited to inheritance as a means to acquiring land. Women of wealth are free to purchase land, and in fact do purchase property, especially business or residential properties.

front of all these men”, a female representative acknowledged.

In disputes over water resources, these local institutions are meant to resolve them collectively. This task, too, is explicitly reserved for men in formal and informal gatherings.

Female-only WUAs were founded in a few districts in the Sana’a and Dhamar governorates in 2008, but they are mainly inactive due to the members’ lack of capacity in literacy and management skills.

Decision-making is often perceived differently from controlling the use of economic resources. While men continue to be perceived as the main decision-makers at household level, the role of women in controlling the use of resources has increased since before the conflict (GenCap, 2016).

Women and water user associations

Women are involved in decision-making in the water user associations or similar groups. Women’s groups adopt and implement female-related activities within the WUA and supervise some female-related activities, such as training, awareness raising, and sometimes financial management.

There has been a slow and subtle change in the roles of women in rural livelihoods, with women more often earning money and continuing to contribute significant – though usually unpaid – agricultural labour. As the role of women changes, there may be more opportunities for them to be more, and officially,

included in water-related decision-making. These roles could be enhanced in formal institutional settings as well as community-led or informal water use and management. (Guppy and Al-Nabhani, 2022)

Despite the efforts to promote women’s inclusion in the WUAs funded by international donors, women are excluded from higher-ranking positions – such as head, secretary-general or financial officer – as well as from positions in operation and maintenance.

Women’s participation in water management is essential, and the modalities suggested to guarantee effective, meaningful participation are covered more in detail in the Gender equality and women’s empowerment and Water user associations sections of the “Partnerships and Approaches” chapter, below.

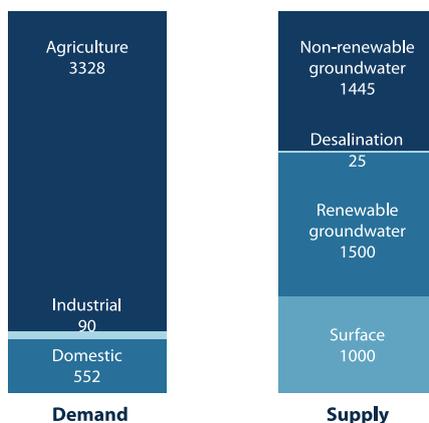
Water balance

To introduce the holistic water resource management strategy for Yemen, we will start with a rapid review of its water resources.

After 2010, updated and verified data is scarce. To address this deficiency, UNDP and KfW commissioned a study to bridge the data gap from 2010 onwards using remote sensing and satellite data analysis techniques.⁵ Based on the data available, the water balance in Yemen (in terms of demand versus supply), can be summarised as in the chart below.⁶

Yemen water demand is estimated at 3,970 MCM per annum. Approximately one third of that water demand is met by pumping non-renewable groundwater.

Figure 4. Water balance in Yemen (mcm/annum)



5 Climate Hazards group InfraRed Precipitation with Station data (CHIRPS), evapotranspiration data from WaPOR, stream-flow data from FLO1K and groundwater anomalies derived from Gravity Recovery and Climate Experiment (GRACE).
 6 Unless otherwise specified, all estimations quoted in this analysis are from “Water availability in Yemen”, published in 2021. That report actualises published data sets making use of modern remote-sensing analysis techniques.

Supply side

Surface water

There are no permanent rivers in Yemen. The streams draining groundwater are seasonal.

The total discharge of excess rainwater into the sea varies, and is estimated to be no more than 270 mcm per annum.

Rainwater harvesting

The main types of rainwater harvesting techniques include:

Terrace harvesting

Thousands of terraced fields have been constructed on steep, rugged mountain slopes using simple, highly effective methods of harvesting rainwater, which is collected in the terraces and soaks into the shallow soil. Low walls at the edge of the terraces prevent run-off from flowing down to the next terrace and allow the passage of run-off through sheet flow, which prevents damage to the terraces from water accumulating at certain points.

Cisterns and sub-surface cisterns

In many areas cisterns are used to conserve rainwater. The cisterns of Tawaila (rain flood harvesting) and the Tawaila tanks, are Aden's best historic sites. According to Yemeni journalist Huda Al-Kibsi, active cisterns may be found in Beit Bawss, Hababa-Yemen, where the town surrounds the large cistern basin where water from the terraces of buildings is collected. Developing cisterns for domestic and agricultural uses will have a tremendous impact on livelihoods in rural communities and will to some extent help solve urban water problems.

In Socotra, the southern and northern parts of the main island obtain water from cisterns. Cisterns are built using a technique that has been employed in Yemen for hundreds of years.

Traditional cistern and pond building (catchment and rooftop water harvesting) was neglected until the end of the twentieth century, when the overexploitation of aquifers became evident.

Dams

During last few decades, a number of small dams have been constructed to capture seasonal floods or springs from the small tributaries of the catchment areas.

Spate irrigation

Spate irrigation is an ancient water harvesting system in which floodwater is diverted from its riverbed and channelled into basins where it is used to irrigate crops and feed drinking-water ponds, serve forest and grazing land, and recharge local aquifers. In Yemen, large traditional spate systems consisting of numerous individual intakes and canals irrigating areas of up to 30,000 ha were developed in individual wadis. Sophisticated water-sharing arrangements were formalised, with rules relating to water rights that exist in written records dating back at least 600 years (Noaman, 2004). Spate irrigation areas depend on groundwater irrigation as a complementary irrigation source.

Floodwater is one of the most important sources of irrigation in many areas, accounting for the irrigation of 70 per cent of total agricultural lands in Yemen's southern and eastern governorates.

Ma'aayeen irrigation

The ma'aayeen system transfers water from different sources (wells, springs, howam or karst pools) through open conduits or underground tunnels with openings for ventilation and lighting, called naqab, to agricultural lands or for use in rural and urban development. Water sources are naturally at a higher altitude than the areas to which water is delivered. Since the tunnels run downhill, water flows by gravity to the area that needs it. The ma'aayeen system is similar to other systems known under different names in other countries:

- The 'qanat' system in Iran
- The 'aflaj' system in Oman
- 'Karees; in Iran and Afghanistan

Water distribution in the ma'aayeen is usually done according to the 'farda' system. In a large ma'yaan, one farda is equivalent to one day's volume water from the ma'yaan (from sunrise to sunset), or one night's (sunset to sunrise). In a small ma'yaan, one farda is equivalent to water from the ma'yaan for one day and one night (as water is collected in pools at night and land is irrigated during the day). Spate irrigation involves inundating agricultural plots, surrounded by field bunds called 'soum', which are typically 50-60 cm high. The farmland is served by diversion canals of up to several kilometres in length.

Groundwater

Water wells

Over the last several decades, tube wells and motorised pumps have been used to supply growing populations and extend irrigation. The development of new wells has expanded rapidly, and water tables have declined in many areas. The economic boost of the 1970s and 1980s, in addition to remittances from workers in Gulf countries (which accounted for billions of dollars), opened intensive investment in groundwater irrigation.

Many farmers are pumping groundwater from wells using diesel or electric pumps and, more recently, solar power.

The well-drilling market in Yemen is well developed, with modern rigs capable of constructing wells hundreds of metres deep, and with diameters sufficient to host the highest-performing submersible pumps on the market. About 900 water well-drilling rigs in use are owned by individuals or companies that generally do not have any permits, despite government legislation limiting the drilling of wells. According to NWRA, about 278 rigs are officially licensed, while about 700 rigs are still unlicensed. Thus, only about 28 per cent of the total rigs in Yemen are officially licensed. The drilling sector is focused on performance and efficiency, rather than conservation (or even planned exploitation). While the technical capacity of the industry-leading drilling companies meet current international standards, practices such as sealing out the more superficial aquifers to protect them from contamination and overexploitation do not appear to be common. The standard testing routines, moreover, privilege step testing (which provides information about the performance of the wells) over long-duration tests (which provide information about the capacity of the aquifers). Market research is beyond the scope of this work, but the cost of drilling appears to be extremely cheap compared to the international standard.⁷

Many farmers are pumping groundwater from wells using diesel, electric or solar pumps. The yield of wells is between 5 and 50 l/sec. Estimates of the number

of groundwater wells differ greatly. This has to do partly with (unregistered) illegal drilling of wells or wells that have run dry over time. It is estimated that there are 52,000 to 55,000 active wells in Yemen (FAO AQUASTAT, 2008), but the World Bank (2010) estimated that 100,000 tube wells may exist in Yemen. As a result, the annual decline in groundwater levels is typically 2.5 – 4.5 m in many areas, with Sana'a Basin exceeding this (its decline is closer to 6 m/year) (Hydrosult et al. 2010).

Other water sources

Desalination

Desalinating water is mentioned as a possible solution to ease Yemen's water crisis. Despite recent technological improvements, however, desalination remains by far the most expensive solution and requires intensive financial, technical and political efforts in both the construction and the long-term maintenance of the systems.

Desalinated sea-water today costs between US\$0.6 and US\$1.2 per m³, largely depending on energy cost – and that reflects only the water production costs. After desalination water must still be pumped, stored, possibly chlorinated, and distributed to users.⁸

Even in the most optimistic view, the potential for desalination remains limited as an option for urban and possibly industrial water supply in coastal areas. For example, a future supply option for Sana'a would include pumping desalinated water from the Red Sea over a distance of 250 Km, and over 3,000 m mountains into the capital, itself located at an altitude of 2,300 m.

Today, Yemen produces 25 million m³/y of desalinated water, approximately 2 per cent of its water deficit (estimated at around 1,500 million m³/y). In theory, for Yemen to count on desalination to cover this gap, it would have to construct and maintain 50 large desalination plants. Apart from the massive technical challenges and capital cost, the challenges and costs of pumping and distributing desalinated water away from the coastal areas, and the costs and technical challenges of managing such large quantities of brine,⁹

7 Prices as low as US\$20/m for 8" holes in alluvium have been anecdotally reported. If true, this is an extremely low price, and would mean that the drilling company might profit in different ways. It is likely that the logs and well reports might not be reliable from hydrogeological point of view.

8 Desalinated water, in a given situation, is at least US\$1.2/m³ more expensive than any other option.

9 Brine, or extremely saline water, is a byproduct of desalination, and comes with its own environmental problems. Management of brine alone is a technical and economical challenge.

the running cost alone of such desalination plants would absorb around 10 per cent of the annual GDP of the country,¹⁰ and a large share of its energy. That would be 2.5 times what Yemen spends on health care.¹¹

There are at least two desalination stations in Yemen, one of which, Al-Haswah Electricity Station in Aden, produces about 69,000 m³/day of fresh water. The water flows into the network of Aden's water supply. A second desalination station, located in the Al-Mokha area, which had a similar nominal capacity, was destroyed by an airstrike in 2016.

In many places in the country, brackish water appears naturally in either surface water or groundwater. However, the extensive withdrawal of groundwater has increased the salinity of many basins, particularly in the coastal areas. The actual quantity of brackish water has not been determined for the whole country. However, the brackish water usable for agriculture in Yemen is about 300 mcm/y, mostly in the coastal areas (particularly in the Tehama region) (Al-Sabri and Halim, 2012). On the other hand, the amount of brackish water used in the water supply for Taiz City is about 3.1 mcm/y (ACWUA, 2010). It is cheaper to desalinate brackish water than sea-water, and small-scale reverse-osmosis plants, some solar-powered, exist on the market. While this could possibly be piloted as a small-scale solution in some situations, it is unlikely that it could be sustainably and economically deployed on a large scale.

Wastewater treatment

Maybe surprisingly in such a water-scarce country, reclamation of wastewater (both black and grey) is marginal in Yemen.

There is no doubt that, in the long term, reuse of wastewater will be a necessary component of sustainable water management; it is also expected under SDG 6. Lessons learned in other countries, however, highlight the formidable challenges associated with such an endeavour (FAO, 2020).

- The systems necessary to treat wastewater on a large scale are complex, expensive, and require robust construction skills, adequate supervision, and quality control.¹²
- Running such schemes can be even more expensive, and more challenging technically, than producing drinking water. Utilities that are already struggling to maintain a minimum water supply could be easily overwhelmed.
- Consistent performance by the treatment process is essential. Should the treatment become suboptimal, even for a brief period, the use of poorly purified wastewater could rapidly become a public health problem.
- The acceptability of treated water is not a given. There can be cultural objections to using reclaimed water, even for agricultural use.

Water treatment could still be an option in particular situations, such as camps for internally displaced persons, where the scale of operations is more modest than in a large city, simpler technologies can be deployed, and construction and maintenance are secured and supervised. The benefits of such smaller schemes, of course, are also limited in scope.

Fog harvesting

Fog harvesting is mentioned surprisingly often as a possible innovative water source for Yemen. The infrastructure for fog harvesting consists of a metal frame and a nylon net, installed on a very few selected mountain tops.

A UNDP pilot project demonstrated that the water harvest could reach up to 2 m³ per year per unit (UNDP, 2013)¹³, with availability for 6 months a year.

This technology could represent a convenient complementary water source, reducing the burden of fetching water for families living close to the harvesting facility. While the water balance is zero, since the condensation captured in the nets is compensated by less rain, the quantities in play are negligible.

10 GDP was US\$21.6 billion (World Bank) in 2018.

11 In 2015 (latest statistic available), Yemen spent 4.25 per cent of GDP on health care (WHO).

12 In Yemen, pipelines routinely leak over 50 per cent of the water they carry. For comparison, according to international good practice for old but properly constructed systems, losses should not be more than 16 per cent, aiming at 4 per cent (EPA, 2013).

13 Considering the cost of the harvesting units, this is probably the most expensive way to obtain water, barring imported water bottles.



Demand side

Agriculture, food production and water

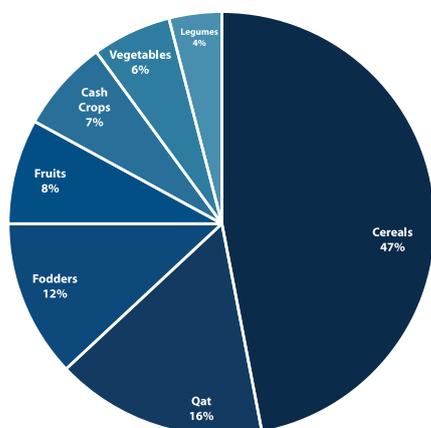
In Yemen, 84 per cent of the water consumed goes to agriculture. Nevertheless, Yemen imports 80 per cent of its food supply.

Agriculture is important in Yemen. In 2020, agriculture constituted 16.3 per cent of GDP, directly employing 25 per cent of the workforce but providing the main

source of income for nearly three quarters (73.5 per cent) of the population (MoPIC, 2021).

While the present desperate situation can be attributed, at least in part, to the conflict (12.7 million people are receiving humanitarian food assistance, and 7.6 million people are in need of nutrition support) (HRP 2021), Yemen, at least in recent times, has never been food self-sufficient.

Figure 5. Agricultural land allocation



Source: Yemen Ministry of Planning and International Cooperation (MoPIC)

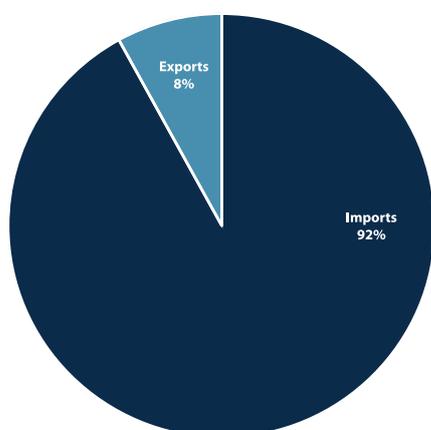
The production of sorghum and maize is very important in rural areas, with nearly half (47 per cent, MAI) of farmed land dedicated to cereals. Even so, in 2010, Yemen imported more than 90 per cent of its wheat and 100 per cent of its rice - the two main staples (WFP, 2010). Those imports are even more relevant today. Yemen also heavily (over 66 per cent) depends on imports for oils, legumes, sugar, white meats, and dairy. On the other hand, Yemen exports coffee, honey, red meat and millet. In 2019, Yemen exported agricultural products for US\$220 million (down from US\$230 million in 2014), while importing goods for over US\$2,500 million (down from US\$3,200 million in 2014) (MoPIC, 2021).

The vast expansion of the agricultural sector that started in 1970s, fuelled by the “groundwater revolution”, expanded irrigated areas from 37,000 ha to more than 680,000 ha between 1970 and 2004, two thirds of which depended on groundwater (FAO

AQUASTAT, 2008). This rose to 1.5 million ha in 2013 (MAI, 2019) and produced many jobs (40.1 per cent of the workforce in 2014) (MoPIC, 2020).

This boom in the agricultural sector was not sufficient to structurally guarantee food self-sufficiency: a vast portion of the expansion of agricultural output went to cash crops, including the infamous qat, which occupies 16 per cent of the farmed land but consumes over one third of all irrigation water and does little to feed an ever-expanding population.

Figure 6. Import and export balance of agricultural products



Source: MoPIC

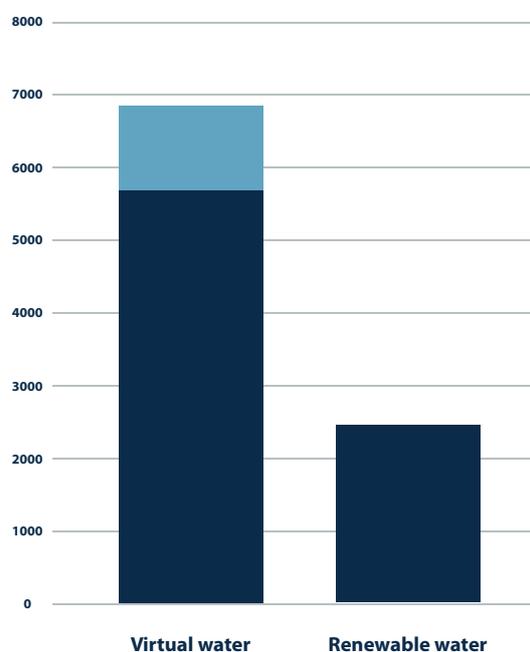
It is estimated that a quarter of the water used in agriculture (up to 1,000 mcm/y) goes to the production of qat and other water-thirsty crops such as bananas: this is in the range of two thirds of the unsustainable portion of water abstractions. But even qat, a very visible anomaly, does not explain the whole picture.

Food security is a complex, multidimensional topic, and a detailed analysis of the very challenging situation in Yemen is well beyond the scope of this work, but some back-of-the-envelope calculations can help to frame the problem – if not in a rigorous quantitative way, at least in the right order of magnitude.

Food security does not necessarily mean food self-sufficiency. Food security can be achieved in different ways, namely through access to markets to import whatever products are needed, and, importantly in cases like Yemen, the virtual water¹⁴ that comes with them.

In 2021, Yemen imported 3.6 M tons of wheat (U.S. Department of Agriculture). This means that Yemen, only as to wheat, imported somewhere between 5,760 and 6,872 mcm/y of virtual water.¹⁵ We can compare this figure with the total water consumption (3,945 mcm/y) and the estimated total renewable water (2,500 mcm/y). Rice is even richer in virtual water.

Figure 7. Virtual vs renewable water



Yemen imports a quantity of virtual water that is more than twice the total of its renewable water resources.

Qat production could and should be curtailed, and agricultural productivity has a large margin for improvement. Different areas can have different dynamics: but the total quantity of water available represents a hard ceiling everywhere in the country, and it is hard to imagine that Yemen will ever be food self-sufficient.

14 “Virtual water”, too, is a complex topic. The most elementary explanation is that every product requires a certain quantity of water to be produced. Importing such product is equivalent, on the water balance, to importing the quantity of water that would have been used if the product had been farmed locally.

15 The global average of total virtual water for cereals (Mekonnen, 2010) is 1,600 Mc/ton. In Turkey, A. Muratoglu calculated the value for wheat at 1,909 Mc/ton in 2020.

This does not mean that Yemen cannot be food secure: it means that food security for Yemen is, above all, about open and fair access to markets.

Agriculture will continue to have an important role in rural livelihoods. Demand for fresh products (vegetables, meat) will always be there, and water-friendly cash-crops production (coffee, almonds, honey) will contribute to food security, strengthening supply chains and assuring purchasing power to rural communities.

But we should also plan for a future where agricultural production will be considerably lower than it is now. The World Bank expects a 40 per cent reduction, but, as is argued here, it will probably be much greater.

In terms of water management, the challenge will be to allocate renewable water resources efficiently and fairly rather than trying to achieve the impossible task of food self-sufficiency. Social sustainability will be more important than the physical sustainability alone.

Urban water supply

Domestic water supply represents approximately 14 per cent of total water demand.

According to the Joint Monitoring Programme (JMP), however, in 2020 only 61 per cent of the Yemeni population had access to basic service (or improved water source), while the portion accessing a “safely managed” water supply, the global standard, is zero per cent. Per-capita water consumption is difficult to estimate: the current estimation of (max) 50 litres¹⁶ per capita/day and the Local Water and Sanitation Corporation (LWSC) target of 80 lpcd are both well below not only the Gulf Cooperation Council average of 560 lpcd, but also the world average of 180 lpcd (Albanny et al, 2021).¹⁷

The challenges to urban water supply are many and complex, and have been analysed in a variety of studies. They are a priority for humanitarian interventions and for immediate public health implications. Some considerations can be made simply on the water management side.

Should the ever-increasing entire population one day enjoy an adequate water supply, with availability at the regional average, the per-capita consumption would more than double.

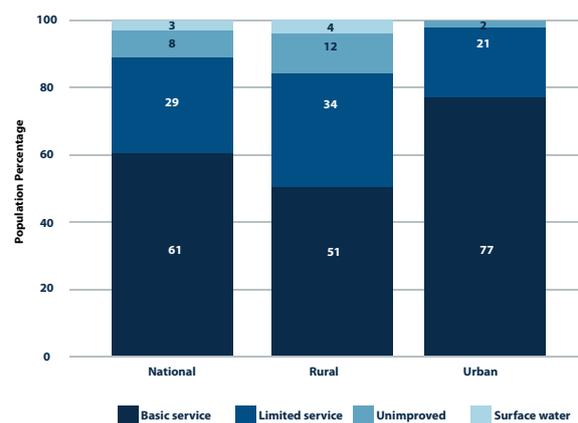
Both the law and customary traditions put domestic needs as the top priority. However, should this prioritisation really take place, the portion of the renewable water supply available for agriculture would shrink even further. In Yemen there are no well-developed water rights, particularly for groundwater use. Traditional water rights and laws have well-established rules for surface water allocation only. This challenge is already playing out in several urban centres, such as Taiz (Riaz K., 2005).

Scarcity of water is intensifying the competition between rural and urban sectors, leading to increased conflict of interest over allocation of water in catchments close to major cities where serious water shortage problems exist.

Industrial water supply

Very little information is available about the industrial water supply in Yemen. The contribution of industry, excluding oil, to GDP is estimated at 10-15 per cent. There are almost 34,000 industrial establishments, with a total of nearly 115,000 employees. However,

Figure 8. Drinking water SDG indicators



Source: JMP, 2022

16 This is the water demand. Pipe losses are estimated to be around 50 per cent, so that the water actually available to users is 25-30 lpcd.

17 Some publications erroneously refer to the SPHERE standard of 15 lpcd. Such reference is incorrect in this context, due to (a) the SPHERE standard is deemed “sufficient”; and (b) 15 lpcd is a minimum indicator for short term survival only in remote, rural contexts. The SPHERE indicator suggested in urban contexts with piped water supply, in emergency, is 50 lpcd (this indicator originated from the experience in the Syria crisis).

a large number of industries have collapsed due to the conflict, contributing to severe unemployment.

Present demand is estimated at 90 mcm per year, or 2 per cent of the total. With the future economic recovery, water consumption from the industrial sector can be expected to increase, putting the sector into direct competition with agriculture and urban water supply for the same resource. Water being precious, water “for business” should be considered a business cost, and should be priced accordingly rather than subsidised. Experience in other Middle East and North Africa (MENA) countries, where industrial water is bundled with the urban water supply and subsidised in the same way, proves that this practice damages both the utilities, unnecessarily burdened with heavy consumers, and the private sector, unable to obtain better service from the monopolist, even when able and willing to pay for it.

Ecological water demand

Natural ecosystems, too, need water. In a context like Yemen, freshwater biodiversity is imperilled through competing demand for water from urban populations and agriculture. Climate change will further increase water variability and scarcity.

According to the Yemen Ecosystem Valuation study, the value of key Yemeni ecosystems is estimated to

be worth approximately US\$287 billion, which is about 14 times the value of GDP (US\$20 billion per year) (EPA, 2017). To protect this asset, a National Biodiversity Strategy, comprising six strategic goals, has been designed by the Environmental Protection Agency (EPA):

- Conserving biodiversity and ecosystems.
- Promoting sustainable use of biological resource.
- Reducing natural and anthropogenic pressures that contributing to biodiversity and ecosystem loss.
- Mainstreaming biodiversity and poverty into sectoral development plans.
- Promoting good governance in biodiversity management.

The strategy is thin in its analysis of the water resources necessary for the conservation of biodiversity and ecosystems. On the plus side, the strategy recognises and supports the central role of decentralised IWRM plans.

In the absence of any reliable volumetric estimation, this aspect of water demand had to be omitted from this analysis. It is nevertheless a component that should be considered in any future WRM plan.



Possible future evolution paths

Climate change

Summary

Projected climate change effects include:

- Mean annual temperature increasing by 1.2-3.3°C by 2060, with warming occurring more rapidly in the country's interior than in the coastal areas (UNFCCC 2013).
- Wide range of projections (increases and decreases) for rainfall, with probable increases in September-November rainfall (MFA 2018).
- Heavy rain events (maximum 1-5-day events) occurring in September-November are expected to increase.
- Increase in sea-level rise of 0.30 m to 0.54 m by 2100 (UNFCCC 2013).

The country will likely face more extreme weather, with stronger and more intense flooding and droughts. The frequency of storms is also expected to increase (USAID 2016).

Greater rainfall variability in the future could exacerbate drought periods, diminishing water supplies more rapidly. Similarly, increased temperatures could lead to higher evapotranspiration rates, further slowing the replenishment of water sources. Extreme events might become more frequent, with increased risk of flooding and reduced potential for groundwater recharge.

Farmers will be obliged to adjust to warmer temperatures and manage the risks arising from more unpredictable rainfall patterns and heavier rains.

Groundwater reserves are likely to be mainly exhausted in another two to three decades, irrespective of climate change, reducing agricultural output by up to 40 per cent by 2030 (World Bank, 2010).

Groundwater availability: three scenarios

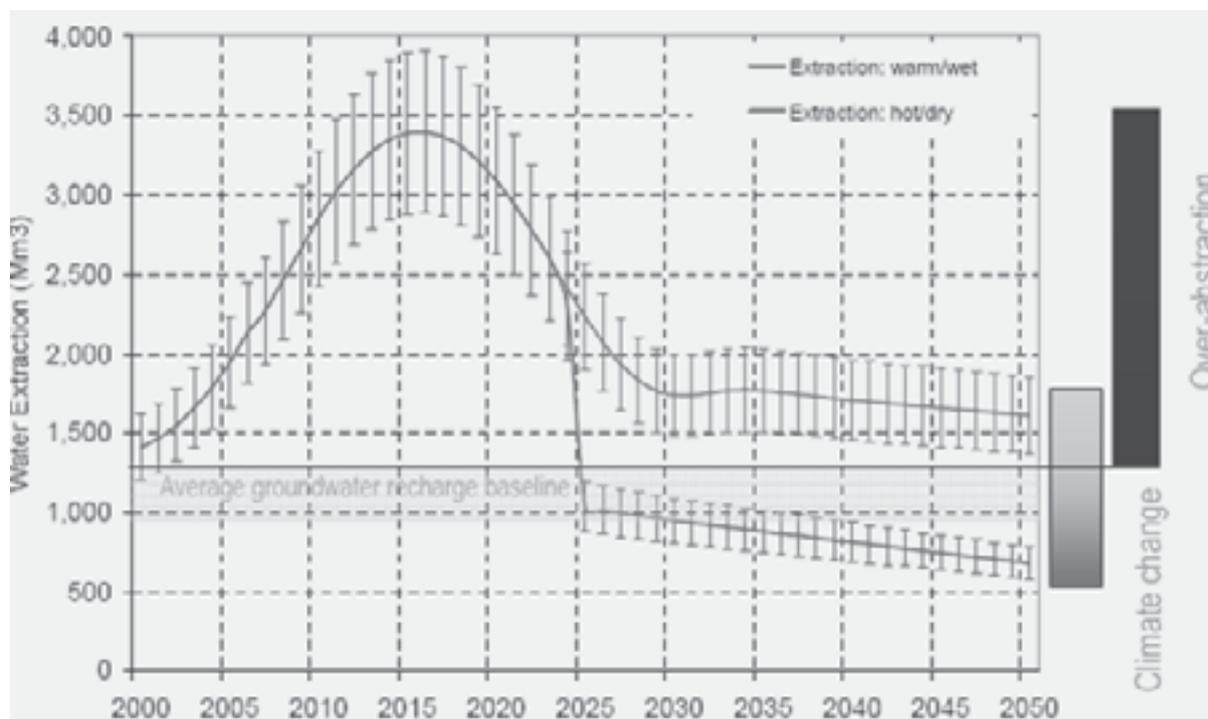
Three simplified scenarios have been used to model future effects of climate change (Wallingford 2009):

- A 'hot and dry' scenario, with warming of 2 -4.5°C and aridity dramatically increased due to the combined effects of low rainfall and high evapotranspiration.
- A 'medium' scenario, with warming of 1.6-3.1°C over the twenty-first century but no significant change in rainfall.
- A 'warm and wet' scenario with warming of 1-1.6°C and an increase in rainfall.

Modelling results used by Wallingford predict that groundwater reserves will be exhausted by 2025.¹⁸ Thereafter, groundwater extraction would be limited to recharge levels, higher in the case of the 'warm and wet' scenario, lower in the case of the 'hot and dry' scenario (figure below). Higher recharge under the 'warm and wet' scenario might delay the exhaustion of reserves for a few years, but under all scenarios groundwater extraction will drop well below present levels. Under the 'warm and wet' scenario, groundwater availability after the exhaustion of non-renewable resources (estimated in this study as 2025, World Bank, 2010) would be about half present extraction rates, under the 'hot and dry' scenario, about one quarter.

18 This is an artificial cut-off date, used for the sake of modelling. Different basins will have different evolutions, and the exhaustion will not be a sudden event. The process, however, is already under way at the time of writing (2022).

Figure 9. Projected changes in groundwater recharge and extraction, 2000 – 2050



Source: World Bank, 2005

Water use trends

The oil boom of the 1980s made a notable contribution to groundwater depletion by enabling diesel-powered water pumps through subsidies for deep-water abstractions. That encouraged sourcing more water from this limited resource to keep planting water-consuming crops instead of adopting water conservation by repairing leaking infrastructure and switching to water-wise crops.

Nationwide, irrigated areas have expanded from 37,000 ha to more than 680,000 ha between 1970 and 2004, two thirds of which depends on groundwater (FAO AQUASTAT, 2008).

Estimates of the annual water demand for domestic (14 per cent), industrial (2 per cent) and agricultural (84 per cent) use of 3,900 mcm far exceed the 2,500 mcm per year estimate of annual renewable resources¹⁹ from both surface water (1,000 mcm) and groundwater (1,500 mcm).

Extensive use of groundwater resources in a context like Yemen is understandable, even desirable: approximately half of the water pumped from wells is sustainable in the long run, as aquifers get recharged by the annual rains.

More than half of groundwater consumption, and one third of total water consumption in Yemen today, is non-renewable. This state of affairs has persisted for some time, and we have reached the stage where this large reserve is close to depletion.

Renewable and non-renewable resources

Statements such as “Yemen is running out of water”, “Yemen is facing a water crisis”, “Yemen is the first country of the world to run dry” are typical results from a quick Google search. Some of those statements come with an associated date, such as “by 2025”, or “in the next few years”.

While these statements may be true in the great scheme of things, the reality is much more nuanced.

19

Renewable water resources (internal and external) include average annual flow of rivers and recharge of aquifers generated from endogenous precipitation.

It is therefore important to clarify some key concepts for policymakers.

The definition of renewable water resources (internal and external) includes the average annual flow of rivers and the recharge of aquifers generated from endogenous precipitation. In Yemen, the commonly accepted values are 1,000 mcm from surface water and 1,500 mcm for groundwater, or a total of 2,500 mcm per year. This is probably an estimation by default²⁰, and further development of renewable resources might modestly increase that number. Whatever the real value, it is a fixed number that

depends above all on precipitation. Without access to non-renewable groundwater to act as a buffer, water management in Yemen becomes a zero-sum game.

Rain falls every year, and when it's over we eagerly await the next rainy season. Some of the water runs off, some evaporates, and some filters into and replenishes the renewable aquifers, which, if properly maintained, can be used sustainably. These are mostly shallow aquifers that fluctuate seasonally, year by year.

20 The Ministry of Water and Environment estimated that total water yield for Yemen in the 1980s, once secondary wadis are accounted for, could have been as high as 2,100-2,400 mcm/y (MWE, 2004).

Figure 10. Groundwater time-series in western Yemen



Source: Acacia Water, 2021

There are deeper aquifers whose water is known as “fossil” water, because at least some of it is probably rain that infiltrated underground some 10,000 years ago, during the last glacial period, when the climate in what is now the Middle East was wet and rainy.

Groundwater is increasingly being abstracted from these deeper, non-renewable aquifers. Therefore, while the balance of shallow aquifers could be positive in the recent, relatively wet years, the balance of deeper aquifers is most likely negative.

More recently, the introduction of solar power probably accelerated groundwater depletion further. While statistics do not exist, the large-scale use of solar power to power submersible pumps is quite visible (personal communication, 2022).

Groundwater basins are mostly independent from one another, and each has a different dynamic. However, the general trend across Yemen leaves no doubt about the overall, progressive, depletion of non-renewable water resources.

“Day 0” of groundwater depletion

If Yemen is consuming more than its renewable share of water, drawing the deficit from the ‘capital’ represented by groundwater reserves, the crucial question is “When will Yemen run out of water?” Several answers to this question – which is not as straightforward as it may seem – can be found in the literature.

First, neither total consumption nor the total stock of non-renewable groundwater is precisely known. Different aquifers have different reserves and are exploited at different rates.

Moreover, water in these aquifers will become progressively more difficult and expensive to abstract, and its quality will become progressively less desirable. Typically, water levels will decrease, and the salinity of water will increase, as aquifers become more exploited. Conspicuous water-level drops are often mentioned as a proof of excessive groundwater depletion. There is also water quality depletion: water with an excess of sodium becomes progressively unfit for irrigation in dry environments, as it tends to salinise the soils (Guoqing 2019). Furthermore, it is both unhealthy and unpalatable for human and livestock consumption, requiring complex, expensive processing (reverse osmosis). The Mukalla aquifer, for example, is believed to hold considerable reserves. The quality of water abstracted from it however, is degrading progressively (Al-Alimi et al., 2013), and will become unusable in the not-too-far future. These phenomena are gradual, and the cut-off lines are contextual.

Yemen will be forced to stop using excess groundwater well before it physically ‘runs out’.

The following analysis will focus on trends rather than dates; where dates are given, they are based mainly on population growth projections.

The end of easy water

Use of non-renewable resources (such as “fossil” aquifers) technically amounts to mining a finite

resource. There is nothing inherently wrong in making good use of such resources, just as there is nothing wrong in mining, for example, iron ore.²¹

Like any other kind of mining, deep groundwater abstraction requires a financial investment for infrastructure and maintenance and consumes a public resource for the benefit of investors. It is thus an activity with important economic and social dimensions.

If we try to frame Yemen’s water uses in this light, we see that the portion of its agricultural industry that “mines” water to produce cash crops (qat first and foremost) does not contribute directly to the food security of the country. Such industry sustains some jobs, and produces wealth that flows mostly to the investors, as in any commodity-based economy.

The conditions and limits imposed on developers of the common resource are set by law – specifically, water law no. 33-2002 and its attached by-law.²² The capacity of the Yemeni State to enforce that law, however, has always been weak, and even weaker at the present moment. In principle, NWRA should be closing down something like 500 illegal wells a day, every day for the next three years.

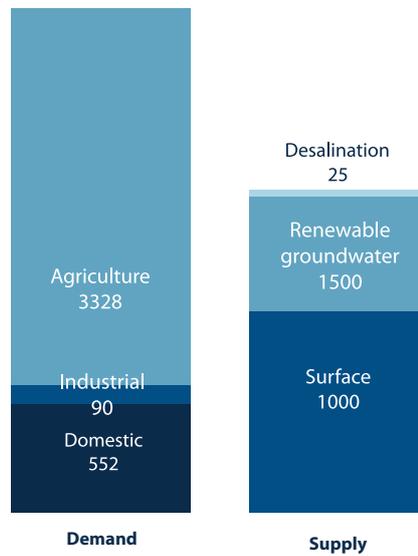
There is unfortunately no reason to think this state of affairs will change in time to stop the exploitation of non-renewable resources before they run out. Competition is a market mechanism that could quickly render water overexploitation less profitable; yet neither a ban on qat production, nor massive, cheap imports from abroad, are likely to materialise in the short term. The wide availability of solar power is only making overexploitation less expensive.

Given the current dynamics of the unregulated market, it is probably correct to assume that the overexploitation of groundwater will stop only when the resource is depleted to a level where either the cost of drilling deeper wells, or the quality of the water, makes it economically unsustainable or unusable.

21 The reality is slightly more complex, as water abstracted from deep aquifers and used for irrigation, is then integrated into the renewable water cycle, and part of it can end up recharging superficial, renewable aquifers. However, such effects are not large enough to be relevant in this big-picture conversation.

22 The goals of the law are: mitigating the exploitation of water resources; protecting water resources from depletion and pollution; improving the allocation of water and the operation and maintenance of water installation; and promoting the participation of beneficiaries in the management, development and conservation of the water resources from which they benefit.

Figure 11. Water balance simulation: no fossil groundwater



The first moment of crisis, therefore, will be around the time when only renewable resources are available (2,500 mcm/y). Figure 11, above, assumes no changes in domestic and industrial demand. The fact that two thirds of the unsustainable water abstractions are today dedicated to qat production, represents, in this scenario, either an opportunity or a nightmare. There are two possible case-limit scenarios:

- Since cash crops such as qat are farmed exclusively for profit, once the water necessary for production becomes unavailable, production of such crops is reduced to sustainable levels (pre-groundwater revolution) serving a niche market. This component of the agri-business is scaled down considerably, harming mostly the cash-crop investors, and investments are directed elsewhere. The demand for qat can be met with imports, as suggested in the NWSSIP in 2005. Agricultural production of staples and non-cash crops products (mostly by poorer farmers) is comparatively less affected, and the effects could be partially offset by increased productivity and efficiency.
- The producers of cash crops conclude that the business continue to be attractive, and start appropriating increasing portions of renewable water, abstracting it from the production of non-cash crops. Poorer farmers therefore lose their livelihoods, and possibly migrate to the cities

looking for economic opportunities or assistance. Non-cash agricultural production is substantially reduced, as is its contribution to food security and rural livelihoods.

Scenarios 1 and 2 are both extreme, but the outcome of option 2 might be more desirable for Yemen.

The most likely outcome will likely be somewhere between the two: how much it leans towards the most desirable outcome will depend on the prioritisation of water resources in a zero-sum game, where the total annual availability depends on rainfall, and the only possible investments will be in the transfer of water between basins (with winners and losers in different basins). How water resources are prioritised in future will depend on how strongly communities of small farmers are able to implement their vision of water management, and protect their water resources and livelihoods from the industrial farmers.

SDG 6 and the second water crisis

The end of non-renewable water resources is an undesirable but expected event. While many projections exist and rivers of ink are expended, realistic plans on how to brace for impact are harder to find.

There is another element of the possible future crisis that is not frequently mentioned.

The statistic of 120 cubic metres²³ annual per-capita share of water is often cited to explain the extreme water scarcity in Yemen. What does it mean in practice?

Common wisdom has it that renewable water resources, no matter how limited, will always be sufficient to cover at least the household needs of the population. After all, this is true everywhere in the world, including in the water-scarce MENA region. If we consider that urban water supply only consumes approximately 10 per cent of present water demand, the argument seems compelling.

We have seen that 0 per cent of the population of Yemen reaches the global standard of ‘Safely Managed Water Supply’ and only 61 per cent has access to the lower tier of service, at least an ‘improved source’. Those are service-based standards that do not reflect actual consumption (JMP, 2017).

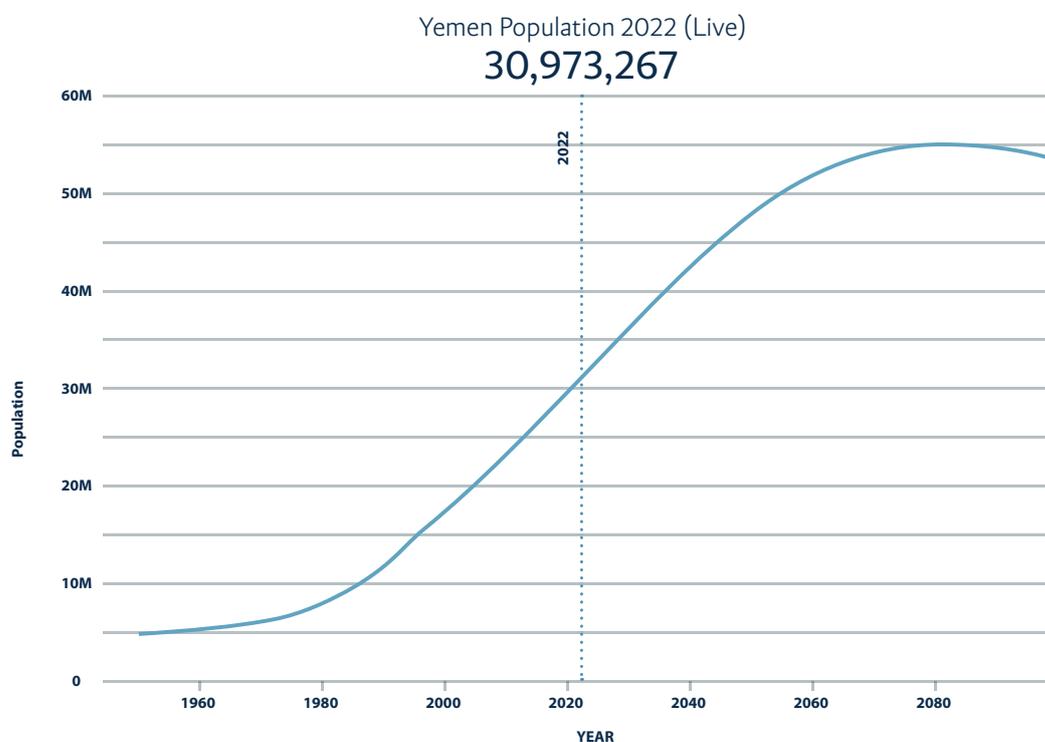
Much work lies ahead to improve the water supply in the country (SDG 6) and progress is desirable, not only for public health reasons. Experience around the world has shown that as the quality of service of water supply improves, so does per-capita consumption.

A consumption level of around 150-200 lpcd is normal for piped water supply in middle income countries. This is the ‘safely managed’ level of service in SDG 6 at which we should aim for the entire Yemeni population.²⁴

The year 2080 may be far in the future, but it is within the lifetime of Yemeni people alive today. If we want to invest in a safely managed water supply, ensuring that Yemen achieves SDG 6 by 2080, even maintaining the present target level of service of 80 lpcd, including losses, we should plan to make approximately 120-150 lpcd for every Yemeni citizen available in the urban water supply.

- 23 Compared to the global per-capita share of 7,500 cubic metres and an average of 1,250 cubic metres in most other countries in the Middle East and North Africa.
- 24 A one-day of supply of qat for a single user has a virtual water content of 500 litres.

Figure 12. Yemen’s population estimated to peak at 55.08 million

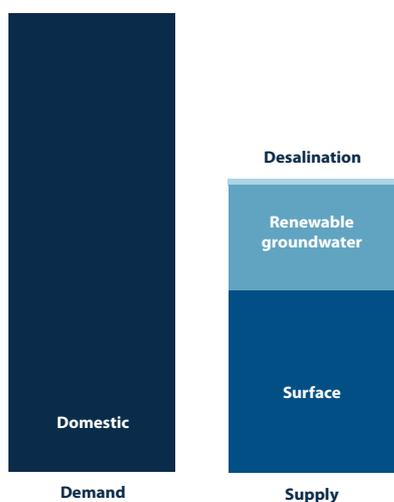


Source: UN-DESA, 2019

If we divide the present estimation of renewable water resources (2,500 mcm/y) by the population (50.08 million), the result is 122 lpcd – somewhat short of the 150-200 lpcd of middle-income countries, but close to the range.

Reaching SDG 6 in Yemen by 2080 would require resources approximating the entire currently available renewable water resources of the country.

Figure 13. Water balance in 2080 – (Simulation: no fossil groundwater) water supply at 122 lpcd



That may be an improbable scenario, but it could help us focus on a real problem: the competition between urban and rural access to water resources.

Yemen is so extremely water scarce that the urban water supply need is likely to reach levels comparable

in scale to the total renewable water resources available in the country.

Both the common law and customary water rules give precedence to domestic water over irrigation. On paper, the problem is easily solved. How easily this will work out in reality is probably not so straightforward.

Such competition is already under way: water vendors are active, and they use agricultural wells to supply their clients.

Urban water supply in cities like Sana’a already makes extensive use of non-renewable groundwater²⁵: this resource will one day become unavailable. Neither LWSCs nor humanitarian support agencies have a ‘plan B’ in place for when this happens. This is quite concerning considering that the scale of the problem is not only about finding alternative water sources: it is about more than doubling the supply from present levels in order to achieve SDG 6.

We can foresee a future where the owners of the water resources in rural areas have the option of using the water for crops, or selling the water rights directly to cities, possibly generating an even higher income.

The most desirable result is possibly in the middle: some water utilised wisely for high-value crops essential to food security, such as fresh vegetables and livestock, and a component sold directly for cash for the water supply, contributing to rural livelihoods.

Once again, ownership of water rights will determine who benefits from the exploitation of Yemen’s most precious resource: its water.

25 The main water supply comes from about 120 water wells located in four well fields: western well fields, eastern well fields, the Musayek well field and the Asser well field. Out of 120 boreholes, 83 were still operational in 2014, operating 14-16 hours per day and able to produce 46,051 m³ per day. By 2017 the production had declined to 10,689 m³/day (Acacia Water, 2021). The rapidly dwindling underground reserves and insufficient replenishment rates have caused severe decline in static water levels, requiring the deepening of wells. That deepening has both geological and technical limits.

Strategy

Yemen is running out of its “water credit”. There is no on-off switch: it is a progressive phenomenon, with ups and downs, and it is already under way. We are observing it now, in slow motion: water levels are dropping, wells are getting dry, and water more saline. Calls for more sustainable use of water and less reliance on non-renewable abstractions have been made for at least the past 20 years, but there is no indication of any attempt having been successful. Drilling wells has never been easier, cheaper, or – thanks to solar energy – more convenient.

Climate change might possibly grace Yemen with marginally more rain. This would be accompanied, however, by higher temperatures, as well as more extreme events, making the rational use of water resources more challenging.

The country is rapidly approaching an era where only the renewable water resources will be accessible. Such resources fall at least one third short of present water demand, and will have to be shared between agriculture and an ever-increasing demand for urban water supply. Water infrastructure designed for renewable resources (rainwater harvesting) should be prioritised over that dedicated to the exploitation of non-renewables (deep groundwater wells). This is in a context where the water usufruct rights are unclear, and the traditional consolidated practice is outdated.

Water is a ‘gift of God’ and as such cannot be owned. Both tradition and law, however, recognise usufruct rights to water. Such rights (from now on called ‘water rights’), stem from the customary water rules. The water law of 2002 recognises those rules. Traditional rules, however, were designed in a pre-industrial era, and reveal their shortcomings when applied in a modern context. Irrigation rules like ‘ala fa al ‘ala, when applied in the twenty-first century reality, excessively favour the elite owners upstream, disenfranchising the more modest farmers downstream and resulting in the impoverishment of rural farmers, and abandonment of rural areas.

Traditional rules, moreover, are not successful in effectively and fairly regulating the use of groundwater. They treat water as immobile and finite rather than as a mobile, partially renewable, communal resource to be holistically managed. The consequences are similar: rich elite landowners privately enjoy the benefits of a common resource at the expense of the majority.

All those, unfortunately, are dynamics that already exist, and have the potential to become worse as the availability of water decreases. In perspective, however, the most problematic consequence of poorly defined water rights is the lack of clarity on the critical conflict of interest between agricultural water use and urban water supply.

This problem will become increasingly critical in the years to come.

Both traditional rules and the law are silent on this point. The Koran does include “the right of thirst”, where it is forbidden to deny drinking water. Urban water supply could be considered a modern definition of drinking water, in which case urban water supply should be given precedence; but in the absence of clear guidelines, harsh conflicts of interests must be expected. There is certainly a need for consolidated practice to serve as precedent.

Given the current unregulated market, it is probably correct to assume that the overexploitation of groundwater will stop when the resource is largely exhausted. This will happen at different moments in the different basins – and even if all unauthorised water abstractions were somehow to stop overnight, this “illegal” water would not be available in any event.

Given the present situation, a return to sustainable water use will be inevitable.

The battle for rational and equitable use of non-renewable resources is lost: more can and should be done to ease the transition to a renewable-only world and to minimise the human costs, conflicts, and inequalities deriving from it.



This does not mean that attempts to enforce the law and manage abstractions from non-renewable sources should be abandoned. But it is likely too late to hope that control measures could be scaled up to an extent that would guarantee the rational and equitable use of the resources before they become unavailable.

We need to pay attention to two epochal forces.

The first is represented by the eventual loss of one third of the water used by farms.

Switching to renewable resources could result in a reduction in overall agricultural output of 40 per cent (World Bank, 2010) or more. Yemen does not have the water resources ever to be food self-sufficient in wheat and rice, its staples, or in sugar and oil. Nevertheless, local agriculture will always contribute to food security, meeting local demand for fresh products (produce, dairy, meat), and cash crops for export (coffee, almonds, honey). Abandoning qat farming would absorb most of the decreased water availability, cushioning the impact on the poorest rural communities. This will be possible, however, only if the renewable resources are protected: should commercial farmers appropriate the renewable resources after their wells become unavailable, the

demand for qat is such that little water would remain for any other kind of farming.

The second is represented by pressure from urban water supply.

Urban water supply is severely below international standards, and heavily dependent on non-renewable abstractions. The combined effect of urbanisation, population growth, overdue service improvements and the switch from unsustainable abstractions will demand the appropriation of a predominant portion of the renewable resource requested by agriculture. The extreme-case scenario foresees that all the water in Yemen could be necessary to supply the cities.

In the absence of a strong government or a strong civil society to counterbalance the power of the most powerful actors in the rural areas, the do-nothing scenario might end up looking like this:

Rural villages will be largely abandoned. The majority of rural population will live, destitute, in the cities. The rich landlords controlling local water resources will transform them into cash through qat production, and will become water vendors supplying the cities with unsafe water. The cost of water will be prohibitive,

almost all food will be imported, and public health in cities will be in a permanently precarious situation.

Conflicts over water might be between communities, even within clans, for the control of the finite sustainable water resources, and between disenfranchised urban communities accessing insufficient quantities of poor-quality, prohibitively expensive water, and rural suppliers.

The best-case scenario, on the other hand, might see empowered rural communities, with strong women's participation, fairly representing community interests, empowered by the ownership of the infrastructure and water rights enabling the exploitation of renewable water resources (spate irrigation, dams, sustainable wells). The infrastructure will need to be resilient to extreme events, properly monitored and maintained by knowledgeable communities, and supported and protected by law and by local branches of government.

The water rights associated with each water infrastructure will be negotiated in accordance with the law and inspired by tradition, but will need to be negotiated fairly, acknowledging the technologies available in the twenty-first century and the consequences this brings to the balance of power between riparian, rural and urban demands.

NWRA seems well placed to provide technical expertise and a good-practice reference frame supported by scientific knowledge and field evidence.

The limited capacity of NWRA, and the need to separate the collection and 'ownership' of information from this advisory function, will need to be taken into consideration.

Communities should be empowered to decide how to share water equitably among farmers, and possibly reduce the farmed areas and sell a portion of water rights to regulated vendors, ensuring at least basic cleanliness and chlorination and thus becoming sort of decentralised small-scale urban water supplier.

Yemen will still have to import most of its food (and qat), but will access local fresh products, and may be able to develop profitable high-quality niche exports, such as specialty coffee. Rural communities may enjoy desirable livelihoods, reducing urbanisation pressure, and cities will be able to augment their water supply with water that meets minimum quality standards.

The present strategy has been developed according to the principles of IWRM.

IWRM goes beyond developing plans that guarantee equilibrium between water supply and consumption. It is an intersectoral approach to water management that recognises water as a public good and acknowledges that the many different uses of finite water resources are interdependent. The benefits from their exploitation must benefit all parts of society equitably. This is especially important in Yemen, where the overexploitation of non-renewable resources, far from benefiting all of society, has enriched a few at the cost of permanently impoverishing large numbers of rural citizens.

This strategy emphasises the use of evidence and real-time monitoring to inform decisions that require improving the monitoring system. It also calls for phased engagements to reactivate water-resource monitoring by selecting a pilot basin in which to:

- Rehabilitate the existing water resources monitoring network.
- Expand the existing monitoring network.
- Strengthen coordination links with water-using agencies (water supply, irrigation, private sector), the Statistics Agency, the Meteorological Agency and the Environmental Protection Authority, as well as donors.
- Improve and develop the national water-resources database system, including expanding and enhancing the use of existing open source databases.
- Develop capacity.

Combination of techniques that can be adopted:

- Well Inventory.
- Automatic data-loggers and other monitoring stations.
- Satellite image analysis.
- Processing of socioeconomic data.
- Digitising and GIS applications.

The strategy has been divided into three pillars, mirroring UNDP practices in the Yemen Office. They are: (a) Water and Food Security; (b) Water and

Governance; and (c) Water and Peace. However, water resources management is inherently a cross-cutting topic, with technical, social, economic, and legal ramifications. No water system is viable without proper design, implementation, technical and financial management, and clear ownership, in an enabling environment where benefits are equitably shared, the rule of law is respected, and drivers of conflict are mitigated.

Implementation of the strategy requires a holistic approach where all the elements of the strategy are recognised as fundamental to achieving the final objective. This will require flexibility in the redistribution of resources among the three pillars, and thematic coordination between the practices. Therefore, UNDP takes adaptive management to be flexible as to the sequence of the support to be provided.

Water and food security

Food security in Yemen will never mean food self-sufficiency. The water resources available to the country are simply not sufficient. For Yemen, food security means access to markets. This does not mean that there is no role for agriculture: local products will always be in demand, especially fresh produce that can only be produced locally. Water has, and will always have, a fundamental role in enabling rural livelihoods.

Agriculture is inextricably linked to the availability of water. The development of flood-resistant, modern, and efficient infrastructures for the capture and use of renewable water (rain, surface, and shallow groundwater) is thus an absolute priority to ensure that crops can continue to be grown even after non-renewable water has been exhausted.

The availability of water is only a first step. The prioritisation of which crops will be produced with that water, either contributing to food security (food items) or commercial purposes (qat) will largely depend on who has the control over water rights. WUAs can have a fundamental role not only in managing those infrastructures, but also in ensuring their intended use over time, and protecting them from appropriation by commercial farmers. WUAs are discussed in more detail in the Water and governance section, below.

Water infrastructure

Over the past fifty years, agriculture becomes progressively more dependent on fossil water – at least one third of the total – mostly accessed from wells equipped with submersible pumps. As this non-renewable water is exhausted, many of those wells will become unusable, and will be abandoned. This will force the rural areas to rely once again on traditional designs that were neglected during the ‘groundwater boom’. Such infrastructure includes spate irrigation, dams, reservoirs, and wells tapping renewable aquifers.

Agriculture will lose not only non-renewable water but also the specialised infrastructure that comes with it. There is large scope for constructing, rehabilitating and augmenting traditional water infrastructure with modern criteria and materials, making it climate resilient and usable in conjunction with modern irrigation practices.

Climate resilient’, means that infrastructure must be designed to withstand extreme events, with a longer return time than is the current practice.²⁶

Interventions will not be limited to water capture and storage: water-efficient technologies and improved irrigation practices should be introduced, or augmented, as aggressively as possible.

Such interventions could include:

- Spate irrigation infrastructure, performance assessment, and targeted rehabilitation.
- Feasibility and pilot studies on less water-intensive cropping patterns with a focus on rain-fed agriculture.
- Pilot water allocation planning, using a bottom-up approach (starting from and together with the users).
- Feasibility mapping and pilot studies on the application of ‘3Rs’ techniques (recharge, retain, reuse), with a special focus on rehabilitating traditional rainwater harvesting structures and terraces.
- Pilot use of reclaimed water from urban water supply for agricultural use.

26 Events with a hydrological statistical return time of 1,000 years could become centenary events, and are thus included in the design.

- Conduct strategic socio-economic and environmental impact assessment studies for new infrastructures.

Mitigation of flood risk

We know that the hazard²⁷ represented by extreme meteorological events will become more and more common due to climate change.

While nothing can be done to avoid intense rains, the risk of flooding can be managed by building climate-resilient infrastructures as well as flood forecast systems, and preparing contingency plans to respond to events, increasing the capacity of the communities to cope.

In engineering terms, building a flood-resistant infrastructure means dimensioning it for peak yields with a certain statistical return time. Return times²⁸ are estimated for a particular locality from historical records. Due to the changes in climatic patterns, these are likely to be under-estimations. As it takes decades to statistically estimate new climate averages, longer return times on known records can and should be used instead.

Large individual events that could trigger destructive floods can be predicted by the meteorological forecast network within a few days, in time to trigger local contingency plans. Such plans are highly contextual, and should be formulated during the design of the infrastructure and discussed with the community during the establishment of WUAs.

Introduction of new technologies

While rehabilitation of existing renewable water infrastructure is the priority, UNDP might also pilot the opportunities represented by new technological advances.

Wastewater reuse and small-scale brackish water desalination can be piloted in specific, favourable circumstances, with the caveats elaborated in the sections on desalination and wastewater treatment sections of the Supply side chapter, above. Likewise, innovative irrigation techniques, and 'climate smart' approaches based on mobile phones, introduced in

collaboration with the MAI, can enable more efficient use of irrigation water.

While potentially beneficial in specific circumstances, none of those technologies yet has the potential to be a solution to the big picture of extreme water scarcity. Even the most promising desalination technologies²⁹ (presently at the experimental level), which might eventually reduce the cost and complexity of desalination, cannot solve the problem of moving massive quantities of water over long distances, and to high altitudes, from the coastal areas.

The role of UNDP

To guarantee food security in Yemen, where access to the market and affordability are problems, it is important to increase food production and farm income through appropriate use of water and improved resilience against weather variability, without abusing the renewable water through cash crop production. Drawing on the strong expertise of UNDP in infrastructure work, the interventions will focus first on the traditional water infrastructure, using modern criteria and materials and introducing new technologies. Flood-resistant infrastructure and flood forecast systems are also priorities to prepare for the era without non-renewable water resources, so as to avoid water loss and ensure efficient water use. These works may include any of the following infrastructures and new technologies:

- Rehabilitating existing water infrastructure and agriculture terraces.
- In-stream rainwater and runoff harvesting.
- Rehabilitating traditional rainwater harvesting techniques.
- Wastewater reuse.
- Water efficient technologies.
- Artificial recharge techniques.
- Brackish water agriculture.
- Desalination of water.

27 Reference is made to the risk formula Risk = Hazard x Vulnerability/Capacity.

28 An event with a return time of, say, 100 years has a probability of 1/100 of happening in any given year. Many construction codes prescribe certain infrastructures to be dimensioned with a 100- or 1,000-year return time.

29 Carbon nanotubes, PFRO, MED-TVC, and others.

Support to local food products such as coffee, diverting water from cash crops such as qat, is also important to reduce abusive water use in agriculture. The balance between livelihoods and water use in rural areas should be carefully planned based on appropriate policies and governance. UNDP will support developing businesses with alternative cropping patterns combined with varietal research, using less water-intensive crops.

Water and governance

The country should start policymaking to prepare for a world where fossil groundwater resources are not available. Infrastructure for both water supply and agriculture should be designed to make efficient use of renewable resources only.

A policy and governance system is required for rural communities, which are about to face two challenges: reduced availability of water (by 30 per cent, or even more in some places) and increased competing demand from both commercial farmers and urban water supply. Those dynamics are already in place in different basins all over the country.

The control of water rights will have an overwhelming weight on the future of agriculture in Yemen, the life of rural communities and the water supply of cities. In Yemen, whoever controls water controls the future.

Water user associations

WUAs will be key to guaranteeing the fairness of allocations, sustained maintenance of infrastructures, and decision-making mechanisms. The associations have a great responsibility; they need to be strong, and have the financial capability to last for years to come. They will be created or reactivated learning from past missteps and ensuring effective contribution from all involved, especially women. They need to be supported by a favourable enabling environment.

The associations should be established following the best practice available and taking stock of lessons learned in the past, including meaningful inclusion of women as participants in decision-making.

Some recommendations for the establishment of WUAs can be found in the Partnerships and approaches chapter, below, as well as in the Lessons learned section in the annex.

Water rights

The water law of 2002 respects the traditional rights to benefit from the rain harvest and the naturally flowing flood water (renewable resources). Those traditional rights should be recorded by NWRA, which maintains a register.

Although traditional rules are ill suited to regulating excess groundwater abstractions, they did regulate renewable water resources in Yemen for centuries, and some may think that they would be well suited to regulate a 'renewable only' world. And there are lessons to be learned from the modernisation of traditional infrastructures.

For example, for spate irrigation, the fundamental sequence rule, locally called 'al 'ala fa al 'ala', granted an absolute priority right to the upstream farmers regardless of the size of the flow; the downstream farmers had the right to surplus water. This rule might seem very unfair to the downstream farmers, but in older times, when diversion structures were constructed with traditional materials and techniques, these were frequently washed away, delivering abundant water to downstream. Moreover, the maintenance of such traditional schemes required a large quantity of manpower, including that of the most distant farmers, who thus maintained bargaining power in preserving their rights. Modern concrete weirs, which are seldom breached, replaced the indigenous structures, accelerating the mechanisation of maintenance. This resulted in almost complete control of the floodwater by the upstream users, even before the advent of well-drilling. Such surplus water was used for cash crops like bananas, further reducing the amount of water that could reach downstream users.

The result was that many of the downstream fields were abandoned.

Another serious shortcoming of current practice is that water rights over wells are linked to the property where the well is situated, in turn linked to the property of the land where the well is located. The water pumped by the well, however, may come from a great distance,³⁰ well beyond of the boundaries of the property. If a well taps multiple aquifers (as is common in Yemen), each aquifer will be affected differently. The traditional rule, "harim", requiring a

30 Technically, this is called the 'cone of depression'. It can be metres or kilometres in width, and few centimetres or several hundred metres deep, depending on characteristics of the soil, pumping regimens, and the influence of other cones.

minimum distance between wells, understood this. That distance – 500m – might or might not be appropriate to the case in question.³¹ Further, the harim rule aims at protecting the water rights of the well owner from exploitation rather than the aquifers themselves. Two small wells near each other can tap different aquifers, and, if correctly drilled and used, might not affect one another, while a large, distant well could cause considerable disruption.

Water rights for wells should be limited to a prescribed total abstraction allowance, determined, among other things, by the results of a duration pump-testing. This should be performed by the drilling company, upon request,³² which would inform the client about the maximum performance of the well, its optimal use, and relationships with other wells in the same wellfield.

None of the traditional rules had provisions covering the division of drinking water versus irrigation water. This was probably because population and consumption levels were such that there was no conflict. Both good sense and the koranic rule of “the right of thirst” (whereby no one can deny drinking water) seem to imply clear priorities. However, we are approaching a world in which urban water supply (the modern definition of drinking water) and agriculture will compete for the same resource. This is already happening in practice, with several instances showing the complexity of the situation (Riaz K. 2005).

Agreements based on traditional rules need to be negotiated at the project, village, or basin level, to account for technological advances as well as modern concerns about equity and gender participation, as described above, in the Water and food security section of this chapter.

Registration of such rights is necessary to ensure that any future dispute can be brought before the courts. Fortunately, since water rights concern a renewable resource, this will continue to be relevant in the future, when the country will enjoy an improved legal framework.

Villages and WUAs will need robust technical assistance to support this. Among Yemeni institutions, NWRA is mandated to support and sensitise farmers, users, and WUAs, arbitrate disputes, grant drilling permissions, and register water rights. This is an overwhelming task, given current staffing and funding levels, so that, understandably, so far, the negotiation and registration of water rights have been neglected to date.

To start disseminating improved technical and legal practices for determining water rights, NWRA needs to develop guidelines on their allocation and registration, detailing clear, realistic, transparent steps that can be practically used in the field to facilitate negotiations at the village level. These guidelines should be developed in consultation with MAI.

In the context of the arbitration system, and to be a credible ‘honest broker’, the NWRA culture needs to be that of an advisory body, transparent and without conflicts of interest. The advice would thus be produced transparently, according to predictable principles, and based on objective data collected by third parties such as private contractors or the WUAs themselves.

To create a sense of ownership, it is probably advisable to involve the Donor Water Group as an advisory body so as to guarantee that the guidelines are immediately implemented in donor- sponsored projects.

31 If a license for a well is requested, the distance between one well and another is determined by the relevant authority, based on the results of the studies carried out. In unstudied areas, the water conditions in each area are taken into account, ensuring that this distance is not less than five hundred metres in the main basins. The following must also be taken into account:

- The principle of participation in the rights to use water from new wells whenever the water situation is appropriate, as a condition for the approval of the authority to accept the application and issue of a drilling license.
- The principle of consensus on participation between the beneficiaries of the old wells that were drilled before the application of the provisions of this regulation, taking into account the legal principle (no harm or harm), including paying appropriate compensation to the owners of the wells.
- The limits of agricultural holdings that are subject to the provision of paragraph 16 of the by-law.
- Water tender for wells, so that the hectare share is not less than half a litre per second during the seasonal crop cycle or during the year for annual crops and perennial trees.

32 In Yemen, drillers often perform “step testing” to provide information about the performance of the well. Duration testing, on the other hand, provides information about the aquifer, and is much less common.

The guidelines need to be shared as widely as possible, with the help of the development actors, to create a critical mass of consolidated practice to serve as blueprint for all the country.

Water allocation planning

Water allocation planning (closely linked to water rights) should be conducted during the establishment of a WUA, and provision for periodic reassessment of such allocations, including clear objective criteria, should be included in the statute. The allocations need to be made in a transparent fashion, based on verifiable data, and should include a monitoring plan.

It might seem unrealistic to expect that sufficient water would be reallocated from human consumptive uses to instream ecosystem services in the near term. The value of such services, however, can be considerable, especially for rural populations (including the element of inter-generational solidarity), and communities should be encouraged to consider their benefits when planning water demand management. To better maintain instream ecosystem services, it is essential to consider, in addition to environmental flows, the need to apply the range of environmental demand management options (Pitcock, 2010). While responsibility for the success of such plans will probably be communal, monitoring and compliance should be discussed, and solutions included, in the tasks of the WUAs.

Since detailed information (including average rainfall and recharge estimations) might not be available, this could be a trial-and-error process, based on empirical knowledge and adjusted after a trial period of 1-2 years (and revised every 5-10 years). Simple, realistic monitoring measures (such as water levels and volumetric readings) should be embedded in the maintenance plan and performed by users themselves. It is of paramount importance that the criteria for allocation are specified in writing and clearly linked to the monitoring results, in order to be transparent and uncontroversial. NWRA could be called to arbitrate in case of disagreements. Production of the allocation plans will require robust technical support during the establishment of the project. NWRA should be in a position to continue this technical support after the project funds runs out.

The role of UNDP

First, UNDP will support advocating water rights that incorporate modern standards, including gender dimensions and fair distribution mechanisms such as the division of drinking water and irrigation water. UNDP will also support NWRA in developing guidelines on their allocation and registration. Based on the guidelines, NWRA can improve water resource management by identifying all water use types and users. This inventory will facilitate the development of water allocation strategies.

Second, UNDP will support water allocation planning, as it is vital to maintain a sustainable balance between supply and demand at the basin level. Key to water allocation planning is the involvement of all relevant water users and stakeholders and the adoption of a participatory approach. UNDP supports ensuring that the water allocation plan is mutually agreed and valued by all water users.

Finally, the implementation of effective IWRM requires strong national-local level interaction. UNDP will ensure this interaction by supporting NWRA at both national and local levels – as well as WUAs – by paying attention to the inclusion of multiple stakeholders, protection of the environment, economic and social welfare, equity, participatory and coordinated processes, and the integration of temporal and spatial scales. Strong linkages between national and local-level institutions will help combat uncontrolled drilling and unpermitted abstraction so as to promote water conservation in agriculture.

Water and peace

Conflict is one of a range of responses to water scarcity, and the most disruptive. With increasing reports of conflict, water scarcity in Yemen is reaching the critical point at which it might not only constrain economic development but also threaten social stability.

In Yemen's complex humanitarian crisis, water scarcity, conflict, and climate change impacts are interlinked. The use of water as a weapon intensifies the emergency.

As in every conflict, water is being used as a weapon of war in Yemen, either directly and intentionally, or as unintended collateral damage. Numerous reports have shown that both sides in the conflict have

weaponised water by blocking water deliveries to civilians.³³

Critical water infrastructure – such as dams, reservoirs, distribution lines and pumping stations – has been destroyed by the fighting (including the Al-Mokha desalination station, destroyed by a 2016 airstrike).

The disruption of supply chains makes the sourcing of essential spare parts and consumables more difficult and expensive, and the protracted instability is causing a slow but inexorable ‘brain-drain’ of competent technicians and experienced operators.

There are multiple drivers of conflict concerning water that have much deeper, longer-lasting, and potentially devastating effects on the future of Yemen and its capacity to thrive as a society.

Some of those drivers have been mentioned in the previous chapters; others are analysed in depth in the Conflict analysis chapter, below. They can be briefly summarised as follows:

- Physical water scarcity, including appropriations from neighbouring farmers, villages or tribes.
- Insufficient capacity to pay for abstraction or for maintenance of water schemes.
- Unfair distribution of usufruct water rights that favour particular landlords at the expense of others (the long-standing upstream and downstream competition, and more recently competition for groundwater).
- Urban-rural competition for the same resource (and lack of a water rights blueprint to guide negotiations).

The present analysis highlights how all the above drivers are likely to worsen in the future, as water availability declines, and redistribution of renewable water resources becomes necessary.

Water rights that are clearly understood, fair, equitable and enforceable can play a fundamental role in defusing some of those conflict drivers.

A clear articulation of water rights, however, represents only a starting point. The process of

negotiating and implementing such a framework will be the hard part.

Conflict prevention

Water user groups and associations can defuse some of those tensions before violence breaks out. Community-based dispute resolution can decrease the risk of water-related violence somewhat. However, the challenge of empowering, sustaining, and maintaining such structures is significant.

WUAs can have an important role in supporting both the central water law and traditional water rules, norms and laws. Disputes would likely arise if rules and traditional agreements were not adapted to the new situation. This should be discussed during planning phases and at the very start of community consultation and implementation. Consultations should involve sitting with stakeholders – including downstream, upstream and beneficiary male and female farmers – to discuss changes. Properly capacitating community champions, or ‘insiders’, can be a key solution to peaceful water use.

Keeping wider communities – beneficiaries, neighbours who will not benefit, upstream communities and, most importantly, downstream communities – informed and engaged will be important in reducing disputes and disgruntlement within communities and districts or between districts. It is also important to be explicit about what infrastructure will achieve, in order to reduce future dissatisfaction with any subsequent work (Guppy, 2022).

Apart from formal groups, there may be opportunities to establish social mobilisation teams, training them as ‘champions’ or ‘insiders’ for water peacebuilding (Guppy and Al-Nabhani, 2022).

Conflict resolution

In Yemen, there are two basic systems for conflict settlement: judiciary and arbitration. There are usually several levels of arbitration in this system, beginning at the village level and ending at with the tribe’s “Sheikh of Sheikhs”.

According to current practice, water disputes are first brought before the village aqil, and if he fails to resolve them they are submitted to the sheikh responsible for the area. NWRA can also intervene in resolving

the conflict if any party or parties to the conflict officially approach it. If no agreement is reached, NWRA may refer the case to the courts

At the time of writing, the courts in Yemen still function, but the capacity of the judiciary is very limited and disputes can take several years to resolve.

Water-related conflict mediation mechanism

As a first step, capacity development and awareness raising of sheiks or tribal leaders as conflict resolution mediators will be essential. However, sheikhs can compete with other locals for water resources as they themselves are usually the largest users of both groundwater and surface water in a given locality. The resulting conflict-of-interest conditions reduce both the credibility of their impartiality and their ability to make fair judgments that can satisfy all parties. A third-party monitor should therefore be included in the conflict resolution mechanism. Mediators provide an alternative path to sheikhs for resolving water-related conflicts peacefully, but they often have difficulty in gaining the trust of all parties. It is important to institutionalise the mechanism of mediators through the collaboration with WUAs and sheikhs.

Gender and conflict resolution

In Yemeni society, disputes are often solved only by men. Yet women can be powerful instruments in dispute resolution.

Although women have many constraints to expressing power in public or official settings, they can wield considerable influence, particularly in the household where they can influence the decisions of men.

Women can be ambassadors in disputes where the presence of a man from a different tribe could trigger a negative or violent response. A gun would never be used against a woman, for example: respect for their gender can also be a vehicle for negotiation.

Women can have open discussions with women from other villages, including influential women such as the sheikh's wife.

Women and girls could be trained as social mobilisers to contribute to water-related conflict mitigation in formal or informal roles. This would allow them to contribute to peaceful water solutions despite the barriers to their involvement in formal processes. As a part of social mobilisation duties, women's training in conflict mediation could become more socially acceptable (Guppy and Al-Nabhani, 2022).

The role of UNDP

As the causes of water-related conflicts vary depending on regional contexts, UNDP will support NWRA in conducting conflict analysis at the community level. Conflict analysis should identify opportunities for managing or resolving disputes without recourse to violent action. Through the process of conflict analysis, NWRA will be further empowered to manage water allocation and registration.

The conflict prevention mechanism will be created and the capacitation of WUAs will be supported to play a key role in conflict prevention at the community level by regulating water use in a participatory manner.

In terms of water-related conflict resolution, UNDP will support both the formal justice system and the arbitration system. Especially in rural areas not reached by the formal justice system due to insufficient resources, a fair and impartial arbitration mechanism will be required so as to avoid conflicts. In the era without non-renewable water resources, more water-related conflicts will come about not only within but also between communities (such as upstream and downstream communities). Conflicts will become more complex and their resolution will require a more comprehensive approach. The establishment of a sound conflict resolution mechanism adapted to the regional context is challenging but needs to be set as a priority. UNDP aims to promote water-related conflict resolution mechanisms by piloting mechanisms that can be expanded to other sources of conflicts as a driver for peace at the community level. The engagement of women is also important for effective conflict management and a fair arbitrage mechanism.

Partnerships and approaches

UNDP will continue to partner with and support the MWE in ensuring that social, economic and environmental objectives are met through improved management and rational use of water resources in Yemen.

Ministry of Water and Environment

MWE was established in May 2003 to reorganise the water sector, with the aim of creating an institutional structure for integrated water management and prepare the necessary institutional and investment conditions to face the growing water problem in Yemen.

Climate change, compounded with the existing unsustainable use of water resources by over-exploiting aquifers, is aggravating water scarcity. This needs to be urgently addressed by shifting sector investment and moving from non-renewable to renewable water resources. Furthermore, the context of the country has changed considerably since the development of the existing strategy, highlighting the need for its updating.

National Water Resources Authority

Over the last decade and before the current ongoing crises in Yemen, the Government and other water-related United Nations and international NGO projects have focused on capacity-building of water institutions. Some progress has been achieved on a sector-wide basis.

However, limited capacities in terms of institutions, trained manpower, equipment, and other relevant resources have inhibited the achievement of water management objectives.

NWRA was unable to expand its activities and continue the decentralisation process with branches in other basins, and was unable to retain its trained

contracted staff. More than 40 per cent of the NWRA workforce were contracted, and their salaries paid by donors.

Some branches were unable to fulfil their work plan due to shortages of qualified staff and limited budgets. Several senior NWRA experts have retired, and others are close to retirement age. Unfortunately, retired experts were not replaced, and the gaps remain.

Implementation of the National Public Awareness Strategy is very limited, and nothing appears to be happening at the branch level.

NWRA has made some progress in acquiring technical capacities in many areas related to water resources management, but still lacks skills in hydrogeology, socioeconomic and water use survey, water resources assessment and planning, data base management, remote sensing and geographic information systems.

Like many Yemeni governmental institutions, NWRA has a very limited capacity at present. Yet it is a key component at several junctures of the present strategy, given its mandate to support and sensitise farmers, users, and WUAs, arbitrate disputes, and register water rights.

The strategy sees NWRA in the following important roles:

- Supporting the establishment of new and existing WUAs; providing awareness and expertise about the hydrologic and hydro-geologic features of the basin.
- Providing technical expertise to WUAs after their establishment.
- Advising and mediating in the negotiation of water rights, and providing expertise in disputes

- In collaboration with MAI and the Donor Water Coordination Group, developing guidelines on water rights allocation and registration.
- Detailing clear, realistic, transparent steps that can be practically used in the field to facilitate negotiations at the village level.

This is in addition to what NWRA is already doing in the field of licensing wells and monitoring basic hydro-meteorological parameters.

The task is clearly overwhelming, given minimal staffing and funding levels, and a level of support will be necessary.

NWRA has a network of seven field offices across the country, manned with staff competent in water management, hydrology, and hydrogeology. Those technicians, and the support they can potentially provide to WUAs and rural communities, represent an invaluable resource that needs to be preserved.

The modalities and scope of the support to be delivered will be developed through coordination with donors and partners to provide an efficient support mechanism. NWRA could, for example, be part of a partnership with academia and the United Nations, providing external technical expertise.

Further partnerships with international companies having experience in information management and analysis of remote sensing data can advise on the best practical course of action for collecting, analysing and disseminating hydro-meteorological data.

Due to the ongoing political crises, most of the headquarters of water sector institutions have been divided into two, with branches separately reporting to the headquarters within their respective boundary. Heads of the water institutions are assigned separately in the north and the south. The legal regulations and laws remain the same all over the country.



Private sector

Water vendors

As LWSCs struggle to deliver a consistent service, users turn to private water vendors either as complementary or primary service providers.

The role of water vendors throughout the Middle East is controversial. They are often seen as competitors to the traditional utilities, complicit in making the difficult job of the incumbent even worse and contributing to the decline in service levels.

They are accused of “unregulated water withdrawals, vandalism or takeover of public sources, and illegal tapping of service provider networks” (World Bank, 2021). Certainly, lack of disinfection is nearly universal, and water vendors have been one of the drivers of the recent cholera outbreak in Yemen (UNICEF, personal communications).

Water vendors often exist in a legislative ‘limbo’: as water distribution services comprise a utilities monopoly, private services are not supposed to exist; thus, they automatically belong to the ‘black market’. Like any unregulated or unrecognised service with large demand, they are prone to all kind of abuses, and in conducive circumstances they can morph into ‘rackets’, engaging in price-fixing, overexploiting water sources intended for other uses, and, when powerful enough, even lobbying for disinvestment in the public water supply.

Something else is also certain: water vendors serve millions of customers. Without them, life in many cities would not be possible for numerous residents.

They cover the gaps left by the public water supply and are not really its competitors. Competition requires choice, whereas these users only turn to the water vendors – which provide a worse service and a worse product for a much higher price – when they do not have choice. This does not necessarily mean the absence of water supply: in Syria, during the conflict, users started to resort to water vendors to complement their water supply when the public service dropped below 50 lpcd (Sikder, 2018).

In the best of conditions, water vendors are honest private businesses, delivering a necessary service, and they respond to the basic laws of the market. If the right incentives exist, they can improve the level of service they provide – chlorinating their deliveries, for example (Sikder, 2018).

In Yemen, the role of water vendors is prominent, and very visible: they fill the gap left by the urban water supply. Both vendors and LWSCs tap the same, non-renewable underground water resources. As those become less and less available, vendors, unlike LWSCs, enjoy the flexibility of changing their supply points. In the long term demand for water, the pressure on rural water supply coming from cities via vendors can only increase, competing with agriculture for the same resource.

In this context, the WUAs can become decentralised water supply utilities: partnership with vendors can guarantee a reliable, safe water supply and fair incomes, or they can become powerful appropriators of water.

Every effort should be made to maintain and expand the service of urban water systems, and ease their transition to renewable water sources. However, it will be many years before those augmented water supply systems are in a position to serve the entire urban population with a “safely managed” water supply (SDG 6). Until then, water vendors are here to stay, and their relative importance is going to increase. This, of course, represents both a great challenge and an opportunity.

Given the right incentives, in the best-case scenario, vendors could become self-regulated entities committed to minimum water quality, supply from renewable sources, and dealing only with rightful water-rights owners. They would then be legitimate service providers, bridging the transition to a more reliable urban water supply.

Finding the right incentives is no easy matter, and requires a deep understanding of the market.

The true extent of this private water market is unknown. Dedicated study will be needed to determine the number and level of consolidation of the vendors (whether individual independent entrepreneurs or fleets controlled by a single owner), and their self-perception.

Drilling companies

As non-renewable groundwater availability decreases, the demand for new wells will probably increase furiously before reaching a sudden decline. While drilling companies will decrease in number, some will survive, maintaining the infrastructure for sustainable exploitation of renewable groundwater. Given their granular presence in the field and their knowledge of

the latest local hydrogeological conditions, the drilling companies could become an important source of information about groundwater dynamics, complementing official monitoring networks. The modalities of such collaboration are all to be explored and will probably be linked to the registration process with NWRA.

Some companies, trained in performing and interpreting duration pump testing, should provide reports to the clients both about the performance of the well and the condition of the relevant aquifer.

Technical consultancies

From many key informants, it was clear that technical expertise – not necessarily limited to water and hydrogeology – is available in the country. There is a gap at the medium level, however: for example, the capacity to review and correct bills of quantity (BOQs) from local designers is poor. This is a constraint, especially in the case of large-scale projects such as urban water supply or wastewater treatment; it can result in incorrect procurement or execution of work. Some organisations, such as UNOPS, are outsourcing all BOQ revision (in the case of UNOPS, to their office in Copenhagen). Nevertheless, capacity-building is obviously preferable to externalisation.

Internationally funded projects should also become opportunities to strengthen local technical capacity. The contracts of international consultancies, when hired, should include a mandatory degree of knowledge transfer to the local counterpart, through either secondments or joint field initiatives.

Gender equality and women's empowerment

Several studies have pointed to women's lack of engagement with water-related conflict mitigation in Yemen. Despite their responsibilities and concerns regarding water and sanitation, and despite the honour and respect they are accorded by Yemeni culture, women have little or no voice in the management of water-related conflict at the community level. International initiatives have included various efforts to build a stronger role for women in the water sector, but these have so far proved unsustainable in the cultural and social context of Yemen.

During the current conflict, the role of women and youth in supporting household needs and livelihoods for the typical Yemeni family has expanded. Since

men are working less due to the conflict, more women are becoming their family's primary earners, leading to increased income-earning opportunities. In addition, the engagement of men in conflicts has increased the number of female-headed households.

Although this is a positive step towards creating a role for women in water-related conflict resolution and peacebuilding, key questions on how women will contribute – for example, whether the WUA will allow mixed meetings or whether women members will have to meet separately; what childcare arrangements are in place for mothers who wish to attend a meeting; and so on – will have to be considered in a proactive and participatory manner in such projects.

Challenges in contributing to WUAs:

- Lack of community-level awareness of how women may play a role.
- Weak awareness of women's contributions and activities on the part of central, regional and district institutions.
- Absence of the State and lack of larger local-level projects and activities in the women's sector.
- Poverty and poor family financial situations.
- Lack of time: 60 per cent to 70 per cent of agricultural work is carried out by women, in addition to such responsibilities as housekeeping, breeding livestock, taking care of children and other household obligations.

Some recommendations on how to meaningfully integrate women into WUAs (Guppy and Al-Nabhani, 2022):

If women are expected to play significant roles in WUAs and other groups, there must be agreement among all members as to how these challenges will be eased. For example, there may need to be changes in when, where and how meetings are run, provision of childcare during meetings, and flexibility as to how perspectives and opinions are received and discussed in the forum.

- The requirement of a fixed quota of women in the activation of new or adjustment of existing water user groups may affect the way in which WUAs function or are perceived to function. This may become a point of dissatisfaction for some parts of the community. Consideration of how best to raise awareness of the positive aspects

and anticipated positive outcomes of this adjustment should be emphasised sensitively by project staff and partners who are well-briefed on the topic.

- Women could be valuable project ‘insiders’, peer facilitators or social mobilisation leaders.
- Female and young members of WUAs could be trained to undertake the task of water monitoring.
- Awareness-raising at the local level is needed to increase recognition of the fact that women can play a role in water-related conflict reduction and mitigation. As this falls within the mandate of the NWRA, training, capacitating, and resourcing local NWRA staff to take on this role may be beneficial, particularly if both male and female staff are assigned to it.

Water user associations

The building of positive support from and empowerment of WUAs will be a priority in this strategy, beginning with WUA input into beneficiary selection and ending with appropriate project closure that does not lead to the collapse of the WUAs.

WUAs can have key roles in supporting both central water law and traditional water rules, norms and laws.

They will have to resist pressure from commercial farmers to expropriate renewable water for cash crops. They should also make conscious decisions about water allocation planning between users, crops, and even sharing between irrigation and domestic water supply, for internal use, or as sales for urban centres.

In a renewable-only world, the pressure to control traditional infrastructures – which is minimal at present – will be immense. The opportunity is to act now to create equitable WUAs strong enough to maintain control, even under external pressure.

In the absence – hopefully only temporary – of a strong central government, there is general consensus that the ownership of water schemes and related rights should be given to the users, including strong agreements that secure the benefits of such schemes for the intended use in perpetuity, to minimise the risk of appropriation by commercial farmers.

The WUAs seem well positioned to undertake this role. Many WUAs have been established since 2007, but only a fraction are still operational. If we are to

expect WUAs to develop informed water resource management plans, the communities need a clear understanding of the hydrological and hydrogeological features of their basin.

Lessons learned from the past have highlighted some key elements:

- Need to be financially self-sufficient.
- Perform better when they have physical infrastructure to manage.
- Include meaningful women’s participation.
- Have access to meaningful technical support on WRM.

The use of such infrastructures should be heavily optimised: unfortunately, Yemen does not have water to spare. Users should be in the position to autonomously manage their resource, taking informed decisions about the most rational action at every point as the season advances. Users should have access to all the information they need, and to management plans that make use of such information.

Plans for information generation and sharing should be developed in the design phase and implemented realistically. Data are too often collected, transferred, and transformed into information by third parties with only the needs of distant planners in mind. Information products should be designed in accordance with the needs of the final users and shared with them routinely. With today’s technology this is an easy proposition, provided there is the will to produce the appropriate information product. Users should have a clear plan available on how to use this information to manage the water system (which may be an irrigation system, a well, or something else). There is no value in collecting data about, say, water levels, if users cannot readily access the relative information product (e.g., water-level trends) and corrective action (e.g., timely opening or closing a certain branch of the system).

Users will need high-frequency, real-time information, as well long-term climate updates and a robust early-warning system on exceptional meteorological events, linked to an emergency preparedness plan.

Certain data will be better collected, and possibly analysed, by the users themselves, and potentially shared to third parties: others, such as climatic analysis and meteorological warnings, might come from national or international organisations.



Annexes

Lessons Learned

While many different approaches to tackling the problem of water management in Yemen have been attempted, the formal documentation of lessons learned from those efforts is typically thin.

In addition to findings available in the literature, this chapter reflects numerous personal conversations and semi-structured interviews with key informants, some of whom are now retired or have left the country. While an editorial effort was made to capture the common wisdom of many practitioners with long experience and knowledge of the Yemeni water sector, in the absence of undisputed hard data, this chapter is also based on personal opinions and anecdotal evidence.

The 2002 water law and water user associations

The 2002 water law contains the basis for setting up new organisations in water management: water basin committees, water zone committees (for parts of the basins) and water user associations. It is estimated that some 100 WUAs and over 600 water user groups were formed. Anecdotal evidence suggests that many WUAs withered once intensive engagement in the concerned project was over. Committee members received general support in institution-building, but in pump operation and repairs, committee members are largely self-trained or acquired their skills elsewhere.

There is a large capacity to self-organise in rural Yemen and the technical services for operating tube wells are amply available. There are several conclusions to be drawn from these cases (van Steenberg, 2009):

- The water law and the licensing procedures imbedded in it are important, though not necessarily in a direct way. The fact that, in principle, wells need to be licensed signals that groundwater is no longer an open-access resource. In an essentially tribal society, this demand for regulation – local and central – is remarkable. There is mutual reinforcement in

several cases of local rule and national law, effectively rural pluralism in action.

- Investment in groundwater is surprisingly collective. There is a high level of local management, and local rules include measures such as well spacing, closure of disputed wells, zoning, and bans on sale to water tankers. There is often considerable community effort to improve groundwater recharge.
- Local management is sometimes encouraged by projects. In other cases, communities come together after having seen disaster strike in nearby areas.
- There may be many sources of local leadership – not necessarily the traditional sheikh. WUAs have been created under many projects. In some cases, this has triggered local initiatives towards better groundwater management; in others, local rules were in place and the WUA did not add value.
- WUAs are not the only route to promoting local groundwater management, but that they can play a long-lasting role if properly encouraged.
- The impact of local rules and regulations can be high, and they are an important component in managing local water resources.
- Local management has not been able to reverse the tide of groundwater abstraction.

In a substantial number of cases farmers have established local rules to regulate groundwater use and well development. The arrangements vary. In some cases, this was by mutual understanding and commonly accepted norms; in others, farmers created their own organisation for the purpose. In a few instances, WUAs created by projects served to catalyse restrictions on groundwater use. Though not directly enforced, the fact that there is a water law and a regulating body – NWRA and its branch offices – has strengthened the hand of local initiatives.

Local groundwater management is an essential building block of groundwater security. It is hard to see – given the local autonomy of Yemeni society and the sheer number of wells – how groundwater development and use can be regulated, unless it is grounded in local management.

There is no doubt of the benefits of promoting local groundwater management – preferably from the farmer-to-farmer and the community-to-community mode. To ensure effective and durable WUAs, good practices appear to be:

- Ensure that the basic information is made available for farmers to understand local hydrogeology and groundwater availability. While a large number of studies have been undertaken over the years, results were never shared with those most immediately concerned. Farmers themselves, in many instances, were trained to periodically collect data from monitoring stations, and share those with NWRA: but it is not always clear whether the information products (e.g., trends, averages, projections) produced with those data were shared back with the WUA. It is also unclear whether such products are designed to meet the needs of the WUA or to feed into national statistics.
- Strengthen linkages between water users, local councils and the branch offices of NWRA. There is a long history of local councils acting as arbitrators of last-resort water issues – and this can be further strengthened.
- Combine the promotion of local groundwater management with promoting agricultural productivity. Actual crop yields for the main irrigated crops is only 20-40 per cent of the optimum.
- Streamline groundwater management.

There is a strong foundation for local groundwater management, in which users are accountable to one another - and a corresponding need exists to nurture this more systematically.

WUAs with infrastructure management function

In terms of water supply and sanitation, the World Bank-funded Rural Water Supply and Sanitation Project (RWSSP) was perhaps the most community-driven of the initiatives in that it provides users with

a relatively open menu of choices of service levels (within the technical and resource limitations of the community) and management arrangements.

The policy statement laid out three major principles of a demand-responsive approach:

- Communities self-select to participate in the project by applying for assistance, meeting project conditions for local contributions, and organising for local management.
- Communities participate in designing their water supply and sanitation system, and in selecting the technology and service level that they consider suitable for their needs and for which they are willing and able to pay partial investment costs and full operation and maintenance costs.
- Communities create formal water user associations to manage their water and sanitation systems.

The RWSSP invested considerable resources in establishing and building up the technical and financial management and planning capabilities of democratically elected water user associations. The consumer satisfaction survey findings suggest that the project's strategy for developing communities' capacity and meaningful involvement in planning and managing their own water and sanitation systems is effective. The strategy has resulted in relatively high levels of beneficiary satisfaction and has increased the likelihood that the communities will sustain the systems over their design lives (Dasgupta et al., 2009).

A 2007 report cautioned against 'imaginary WUAs', which have in the past been set up under international projects in order to "chase" benefits or to superficially satisfy project requirements (Guppy and Al-Nabhani, 2022).

In a project workshop, experts noted several key points related to water user groups (WUGs), associations and committees:

- If WUGs are truly representative, they can be drivers of peace. If they are not representative of the whole community, including potentially disgruntled persons or groups, they can contribute to conflict or play a less positive role in projects.
- In some districts, WUGs are overseen or instructed by local authorities. In that case, they

are often not a strong power on their own but are a less powerful part of a water management structure. In some localities, if the local authority is obstructive or does not have a positive relationship with the project, the WUA will follow suit.

- The content and tone of the relationship between WUGs and local authorities affects local agendas or hidden agendas.
- If WUGs are part of a beneficiary selection that is not seen by all to be fair, there can be negative effects throughout the life of the project.
- It is important to involve the WUAs in project preparation, planning and design, as well as implementation, from the beginning. It is equally important to provide training and capacity-building to ensure that they have the ability and skills to act as competent and knowledgeable contractors and partners.
- If WUAs are to be drivers of peace, then capacity development and training specifically on conflict resolution and mitigation is important. If local people can be guided by the WUAs to understand a common ground and accept dialogue as a means of resolution, WUAs can be key to reducing water-related conflict.
- For WUAs to be sustainable, they must be able to collect fees from members or beneficiaries of the infrastructure they manage, or have another source of income that continues after the end of the project. Although the impacts of poverty are increasing in most parts of Yemen, the charging of affordable fees does not appear to be opposed by communities if services are delivered well.

Dispute resolution

Managing conflict is crucial for Yemen. Conflict is the most disruptive response to water scarcity. Responses to scarcity and conflict situations are a test of adaptive capacity: the ability of a society to accommodate change by adjusting its rules.

Traditional Yemeni society and institutions have demonstrated considerable capacity to adapt to the evolving challenges of water communities, continue to develop their own rules, and show some ability to adapt to scarcity. The old harim rule on well-spacing is now evoked almost everywhere to control new well-drilling. Communities also may seek to restrict

deepening, pumping time, or water sales. New users are being excluded through a variety of techniques.

The capacity of central government to regulate activities at the level of individual users is very limited. Typically, government intervention involves a show of disproportionate strength, justified only in extreme cases, after local dispute resolution methods have failed (Moench 1997).

Government moves to improve the professionalism of its water management services by setting up NWRA and decentralising its powers to local branches were a step in the right direction. There is limited evidence that NWRA has helped in dispute resolution.

The decentralisation of some official responsibilities to participatory basin committees and local authorities also may help, although there is no reason to suppose that decentralised structures will be more efficient or less politically driven than centralised ones. However, decentralisation may at least reinforce the power of local communities to control abstraction and drilling.

In the Yemeni context, the only viable solutions are local, participatory, and initiated by the water users themselves. Moench (1997) details the reasons that these solutions work:

- Local people are the stakeholders.
- Government can never have the capacity or the full confidence of local people.
- Every village has its own hydrology and history, and only micro-level solutions make sense.
- It is not government but millions of individuals at the local level who take the decisions about Yemen's water management.

The future of water management and dispute resolution in Yemen depends on local institutions. Those institutions are creakily adapting to water scarcity. There is a role for government to lend a hand by supporting community self-management initiatives through education, training, and intelligent cost-sharing.

National Water Resources Authority

The competence of NWRA officials in the field of hydrogeology, water quality, and water management is an invaluable asset in a country where such skills are essential and rare. The support role of NWRA in mobilising, training, and supporting rural communities,

and helping to settle disputes, has been praised as necessary and unreplaceable.

There is less appreciation of the organisation's institutional work at the central level. Inadequate information sharing and insufficient Information management are often mentioned as a NWRA shortcomings.

In fairness, NWRA has been given a daunting task. Against all odds, it has striven to build strong fundamental tools for managing water resources, particularly in the following respects:

- Institutional reforms and capacity building:
 - a Consolidation of water resources management functions under NWRA.
 - b Creation of the MWE.
 - c All government water institutions under the umbrella of MWE.
 - d Decentralisation process, establishing NWRA branches and coordinating units in several water basins.
- Water policies and legislation:
 - a Preparation of water law and by-law.
 - b National water policy and strategy.
 - c Water quality standard.
 - d National water resources awareness strategy.
 - e Regulating activities and movement of drilling rigs.
- Studies and plans:
 - a Division of the country into water management regions and identification of water-critical regions.
 - b Preparation of water management action plans for several critical basins. A series of studies has been conducted in these basins, such as hydrogeological and hydrological investigation, and socioeconomic, agricultural and water surveys.

- c Groundwater economic incentive study.
- d National monitoring network been established and routine monitoring observations carried out in order to control and predict possible changes in groundwater level and quality. Stream gauges and climate stations were also monitored.
- e Establishment of a national water data base.

There are, however, shortcomings. The most challenging is the enforcement of water law. NWRA has to coordinate with many other entities to enforce the laws and regulations, but their budget for follow-up was very limited.

- Weak coordination with Ministry of interior.
- NWRA budget from Ministry of Finance has always been insufficient to cover routine activities and maintenance, such as the maintenance and rehabilitation of monitoring networks, replacement of damaged stations, and implementation of further studies.
- Due to budget limitations, NWRA was unable to expand its activities and continue decentralisation processes with more branches in other basins, and was unable to permanently place its trained contracted staff as full employees. More than 40 per cent of the NWRA workforce were contracted, and their salaries paid, by the donors.
- Some branches were unable to fulfil their work plan due to shortages of qualified staff and limited budgets.
- More qualified staff have recently retired, and trained, contracted staff members are now working with other NGOs. Reduced staff and lack of recruitment prevents NWRA from expanding its activities.
- Implementation of the National Awareness Strategy is very limited, and probably non-existent at the branches.

A comprehensive analysis of the conflict in Yemen and its repercussions on the water sector is outside the scope of this work. The following notes are based on

Conflict analysis

the recent work of Lisa Guppy and Sadeq Al-Nabhani (Guppy and Al-Nabhani, 2022, for UNDP).

The wider conflict in Yemen is a mosaic of multifaceted local, regional, and international power struggles with numerous root causes. It is indivisible from the social tension and fragmentation experienced by many communities. Although competition for scarce water resources does not always, or even typically, lead to violence, the conflict context of Yemen means that water-related disagreements all too often spiral into community-level violence and conflict. In the present war context, local disputes between clans, families, leaders, or communities may hinder or completely obstruct water initiatives and projects at the community level.

According to researchers from Sana'a University, 70-80 per cent of disputes in rural Yemen are related to water. It has been estimated that one third of the cases taken to criminal courts in Yemen focus on water-related conflict deaths, with an estimated 2,500 people killed annually over water disputes.

Community-based dispute resolution can reduce the risk of water-related violence. There is considerable momentum for peaceful implementation of international water projects, since overall, rural communities in Yemen see international projects as the primary vehicle for improvements in their irrigation water and are positive about project implementation. Nevertheless, many attempts to build equitable local water management structures and mechanisms to support community conflict resolution and mitigation have been less than optimal due to challenges in empowering, sustaining and maintaining these structures and mechanisms.

First order: physical water scarcity

Given heavy reliance on water infrastructure for access, water-related disputes in Yemen commonly focus on water management networks and infrastructure. Disputes have also been triggered by the building or rehabilitation of infrastructure.

Upstream and downstream competition and disagreement is widespread in Yemen.

With respect to surface water, water that is captured affects the availability of water downstream. The farther upstream the intervention, the more downstream users may be affected. It is therefore important for projects to assess the hydrological impacts of activities, focusing on downstream water availability and accessibility.

Water has been a conflict target, with an unknown but significant proportion of water infrastructure damaged or destroyed by parties to conflicts or by community members faced with water disputes. The accessibility of water sources has been reduced in some areas due to insecurity and conflict. Access can be limited by the ownership or occupation of the resource by warring parties; by active conflict taking place near water sources; or by the danger of physically going to a water resource due to unexploded remnants of war.

Second order: economic water scarcity

Conflict has contributed to declining levels of service and a lack of infrastructure maintenance, since resources are redirected to security concerns, and insecurity limits the ability of government and private water suppliers to operate.

Such situations are exacerbated by a widespread decline in public and private payments and funding for water services.

The inability to pay for water also affects self-built water sources, such as farmer-dug or -drilled wells. If fuel costs rise beyond a certain point, depending on the crop or livestock being managed, agriculture becomes unprofitable or unaffordable.

There are also water users who are benefiting from the status quo and would seek to prevent improved water management.

Third order: structural water scarcity

Water scarcity has created a rich history of locally developed norms and traditions for managing and sharing water.

The traditional arrangements are recognised by Law 33 of 2002, which does not contain any provision about water rights other than the request to register them, “without prejudice”, with NWRA. Such registration never took place.

Those traditional arrangements were developed in an era when water management technology for was very different, with different maintenance needs from those of today. In particular, the “ala fala al falal” rule on spate irrigation, once quite fair to all users, applied verbatim to today’s concrete spate structures gives an unfair advantage to upstream users. Moreover, rules concerning wells do not recognise the difference between the property containing the well and its capacity to exploit the aquifer well beyond the property borders.

In allocating and sharing water, moreover, the difference between renewable and non-renewable resources needs to be taken into account in order to make lasting, peaceful solutions.

Many local traditions have been weakened, while others have declined or vanished due to the war context, modernising water infrastructure, socio-political changes, or environmental impacts such as drought and climatic change. The present weak rule

of law creates opportunities for sheikhs and other powerful individuals to claim water resources without local resistance; and many people feel they are increasingly oppressed by a corrupt system.

There are many and diverse public and private agricultural and rural water management stakeholders in Yemen, leading to a complex and often fragmented situation with respect to who are the drivers of water-related conflict and who are the peacemakers.

Corruption, nepotism and systemised self-interest are a long-standing, serious concern in Yemen. At all levels, conflicting interests and powers for water governance limit effective water-sharing and sustainable management. With a fragile governance system, it is common for political, social and economic elites to gain preferential access to water despite water laws and regulations. Water-related inequities based on age, ethnic identity, and other identities can be observed in many parts of the country. This means that leaders in both national and local contexts, are unable or unwilling to fairly and sustainably allocate and deliver water. The resulting, cascading and complex water problems include high non-revenue losses, the continuation of uncontrolled drilling and non-permitted groundwater abstraction, and poorly understood land and water rights.

Ministry of Water and Environment



Institutional framework

MWE was established in May 2003, while the water law was issued in August 2002 (hence there was no mention of MWE in the law). Amendments to the water law were necessary because the expected functional responsibilities were temporarily given to NWRA until the establishment of the Ministry. The amendments provide for the functions of MWE while defining NWRA as its executive and implementing authority.

The main objective of the Ministry is to develop water resources based on the IWRM approach in order to provide: clean drinking water and sanitation services; allocation of water for all purposes; protection against environmental pollution and desertification; conservation of natural resources and rationalising their exploitation through the adaptation and enforcement of relevant legislation; and implementation of awareness-raising programmes that encourage local communities and NGOs in their efforts to reform water and environment conditions. All this aims towards improving public health and alleviating poverty and unemployment.

A number of organisations report directly to MWE: NWRA, GARWSP, NWSA and the Local Water Supply and Sanitation Corporations (LWSCs).

The functional responsibilities and roles of MWE are the following:

- Prepare policies and executive plans related to the water and environmental sector in a manner that secures the best utilisation of the water share assigned to the sector in the water plan.
- Conduct theoretical and applied studies and research and set up facilities, laboratories and networks to supply the population with water for domestic, industrial, touristic and other service purposes within the limits assigned to the Ministry in the water plan.
- Rationalise and enhance the efficiency of use of water allocated for domestic, industrial, touristic and other businesses through guidance programmes and regulatory controls and the introduction of measures and technologies that reduce water losses and enhance conservation.
- Supply the population with potable water good for domestic uses, putting into effect controls and measures that secure compliance with its standards, specifications and suitability for human consumption; and adopt measures and actions that prevent any health hazard to the population, as well as develop and improve the quantity and quality of such services.
- Supply water for various industrial, touristic and other private and public services that fall within the range of the water distribution networks, subjecting them to the application of water standards and specifications control measures in accordance with the various use purposes and in line with the provisions of this law and its executive by-law.
- Install and operate sewerage networks and sewerage treatment plants for domestic and other public use, and supervise sewerage treatment plants for touristic and industrial projects, coordinating with MAI, the local authority and other relevant agencies about the best methods to use treated waste water for irrigation and other purposes in accordance with technical, health and environmental specifications and guidelines set forth by the Ministry in association with related agencies.

- Treat and dispose of wastewater in accordance with standard and environmental specifications prescribed by the executive by-law of this law, taking into consideration that the treated wastewater shall not be disposed of or used except after coordination with the Ministry and the relevant authorities and after consultation and coordination with its users and those who are affected by its use.

General Authority for Rural Water Supply Projects

GARWSP is responsible for the planning of the water supply and sanitation in the rural areas of Yemen and for keeping track of the local councils in implementing water supply and sanitation. The water supply projects implemented by GARWSP were mostly dependent on groundwater. Most of the drinking-water wells were drilled by GARWSP, while drilling licenses and permits for the wells were provided by NWRA. After completion and implementation, projects are handed over to local user associations for management.

National Water Resources Authority

NWRA falls under the umbrella of the MWE, and is responsible for preparing all legislation, strategies, and policies that relate to water resource management according to the Yemen water law. Implementation of these strategies and policies in managing water resources is not the sole responsibility of MWE and NWRA: other institutions (governmental and non-governmental) bear some of the implementation responsibilities. The main roles, and the institutions involved in managing water resources in Yemen, are briefly described in the Water management plans section.

One function of NWRA is to conduct water resources assessment studies in all basins. These include well inventory and hydrogeological investigations; a socioeconomic, agricultural and water use survey; preparation and implementation of regional action plans for priority regions; and creation of water basin committees and water user associations.

NWRA established the national water resources monitoring network and the National Water Information Centre, and had over 850 stations and other organisations around 400 stations. Routine monitoring and data collection (including on ground and surface water, quality, climate, seawater intrusion, and pollution) were conducted by NWRA headquarters and branches. NWRA has built national water resources information systems in headquarters and all branches.

Public awareness has been one of the main activities of NWRA: printing and distribution of public awareness materials, introducing water awareness into school curricula, preparing TV flashes and roundtable discussions on television, radio messages and Mosque lectures, issuing quarterly magazines and billboards at city entrances, and establishing school water groups.

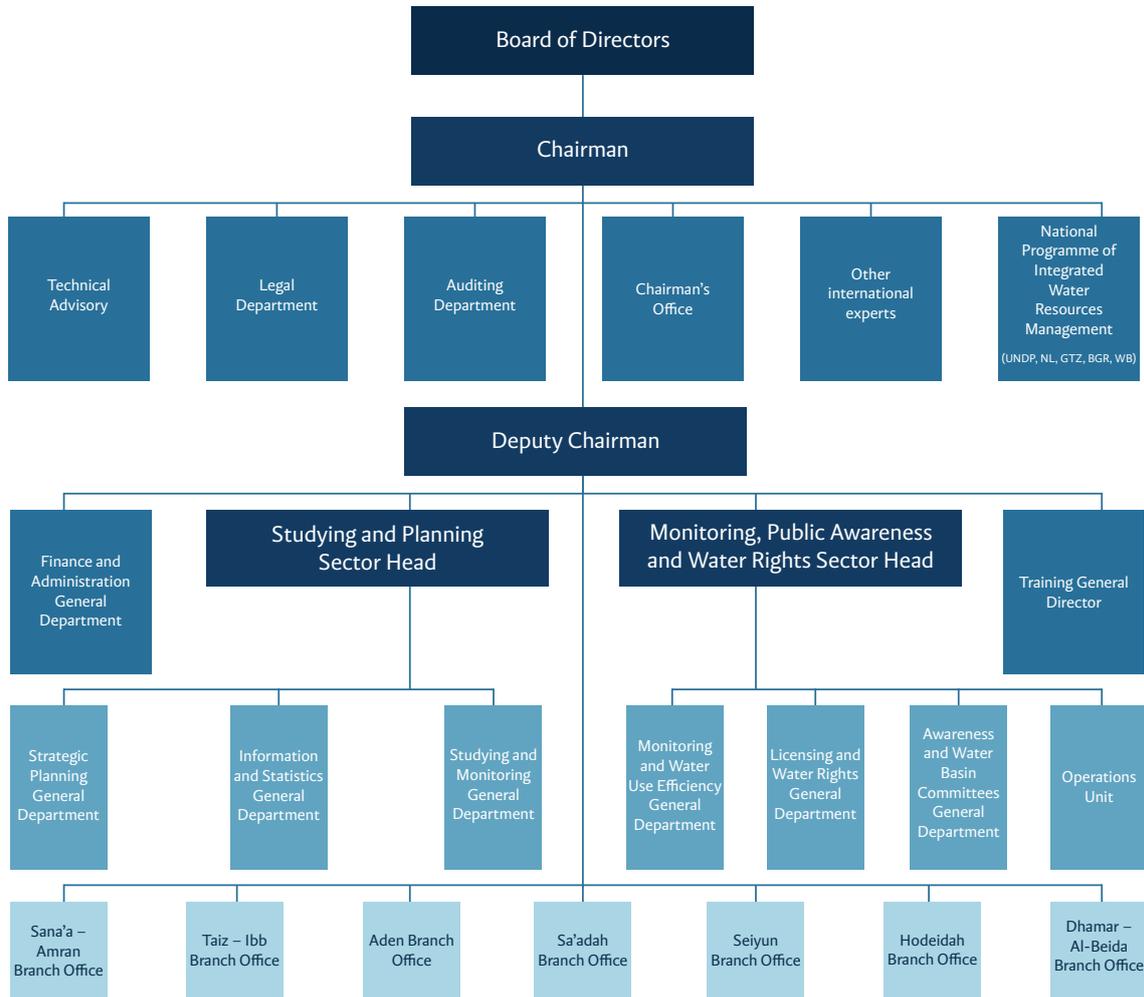
With respect to human resources development, various training programmes were conducted in-country and overseas: technical, public awareness, administrative and financial trainings, community development training, and training for judges, police, WUAs and local authorities.

Coordination is an important task of NWRA, which has to coordinate with all water institutions in Yemen and establish a good working mechanism, particularly regarding the awareness programme, establishment of WUAs, exchange of information, the enforcement mechanism for licensing, and enforcement of the water law. Various actions were prepared to control groundwater exploitation and random drilling, including preparations for the implementation mechanism, which outlined the roles and responsibilities of various stakeholders in controlling random drilling and rigs movement.

A detailed inventory of all drilling companies and individual contractors is stored in the NWRA database.

NWRA coordinates with all government institutions to avoid contracting with unlicensed drilling companies, and monitors the movement of drilling rigs by satellite (fleet tracking unit). It will develop

Figure 14. Institutional structure of NWRA



and implement an appropriate system for licensing drilling companies and issuing permits to drill wells.

Applicants for well permits and drilling license will be required to submit a bank guarantee against violation of any of the conditions set forth in such permits and licenses.

Well permits are issued after the client has committed to all conditions, including installing a water metre not exceeding a determined abstraction quantity, and using the improved irrigation system.

NWRA established an operational unit operating 24 hours a day, linked with a hotline (173) through which the general public can report illegal drilling or other violations.

The NWRA legal department will be strengthened and selected staff will be trained to write up citations for violators. The authority will coordinate with the Attorney General's office to obtain the legal power to effect citations.

National Water and Sanitation Authority

The National Water and Sanitation Authority (NWSA) is responsible for planning water supply and sanitation in Yemen's cities and keeping track of the performance of LWSCs.

The LWSC is responsible for implementation, construction and operation of the water supply and sewerage system. In the past, there was one national corporation; this has now been decentralised to various local corporations in the major cities.

Technical Secretariat for Water Supply and Sanitation Sector Reform

The Technical Secretariat for Water Supply and Sanitation Sector Reform was established within MWE mainly to follow up the reform process and progress in all water sectors. The head of the Technical Secretariat reports directly to the Minister.

The Secretariat played a broad coordination role during the preparation of the NWSSIP. This programme was prepared following the reorganisation of the entire water sector in 2003; the MWE initiated a multi-stakeholder process of preparing a consolidated strategy, action plan and investment programme for the sector as a whole. The strategy clearly defines the policies and approaches of all water sectors, including a detailed investment programme. The Technical Secretariat, which prepares an annual monitoring and evaluation study for all water sectors, also participated in the preparation of the Water Sector Support Programme (WSSP).

The WSSP was a multi-donor intervention over five years prepared by the Government and a core donor group of the World Bank, the Netherlands and Germany, for the purpose of advancing fundamental reforms related to (a) implementation efficiency; (b) coordinated donor harmonisation; and (c) improved water sector governance, through a sector-wide approach programme (SWAP). Programme implementation will be progressively entrusted to mandated national agencies and in-kind support.

The main added value of the SWAP promoted under the WSSP was to move from subsector projects implemented by dedicated project management units under specific institutional and financial arrangements towards harmonised planning.

Environmental Protection Authority

The Environmental Protection Authority (EPA) is responsible for issues related to applying the Environment Protection Law of 1995. The law stipulates an environmental impact assessment for projects which are by their nature a source of environmental pollution (article 36). The EPA is responsible for observing and measuring the pollution of natural resources in the country.

In October 2002, the EPA issued the Environmental and Sustainable Development Investment Programme, 2003-2008, which constitutes the framework for the

Government's environmental policy in the coming years. The programme presents an outline strategy and priority interventions aimed at controlling and gradually reversing the trend of depletion and degradation of natural resources, and supporting human development for the people of Yemen. The programme, already under implementation, focuses on six main areas: (a) Habitat and biodiversity conservation; (b) Sustainable land management; (c) Sustainable water management; (d) Sustainable energy management; and (e) Institutional development.

Water User Associations

The amended water law and the by-law ratified by the parliament are the legal documents. Article 10 of the water law states that it is permissible to form associations, groups, committees or federations for water users, subject to the participation of the community and water users in managing water resources and operating and maintaining its facilities. In accordance with the principles and objectives enumerated in the by-law, groups, associations and federations of water users shall be established in compliance with the statute approved by the competent authority in the Ministry of Labour and Social Affairs, and in accordance with the relevant laws and regulations.

Details regarding principles and objectives; formation of WUAs; membership in WUAs and federations and the required conditions; tasks and functions of groups, WUAs and federations; rights and responsibilities of beneficiaries and users; and general principles for forming committees and their duties and powers, are clearly explained in the By-law.

Clause 13, for instance, describes the advisory function of WUAs. Clause 14 provides for the WUA – provided it represents two thirds of the water users – to make mandatory rules. Clauses 74 and 75 outline the 500-metre distance rule.

Ministry of Agriculture and Irrigation

Until 1996, MAI – at that time called Ministry of Agriculture and Water Resources – was responsible for water resources planning and development. In 1995, that function was transferred to NWRA, and MAI was restructured to be solely in charge of irrigation activities, planning, development, implementation and monitoring. Irrigation, which represents 84 per cent of water use, remains with

MAI, but MAI continues to be heavily focused on surface water infrastructure development rather than on groundwater.

The fundamental policy of MAI is to increase farmers' income and contribute to reducing poverty while reducing the over-abstraction of groundwater. The selected guidelines for this process are the Agenda 21 Dublin principles, in which the water sector is reformed to promote efficiency, decentralisation, cost recovery and participation. The strategy for applying these principles specifies a participatory approach and establishment of WUAs.

MAI has eight directorates, including the General Directorate of Irrigation, and is responsible for providing technical guidance and extension services to farmers, as well as constructing irrigation structures (small dams, canals, water tanks, diversion works). In addition, it supervises specialised authorities in the fields of agricultural research, agricultural and regional development authorities, cooperatives, companies, and projects. MAI functions through its offices in all the governorates.

The National Irrigation Programme, established in the Ministry of Agriculture, coordinates with other organisations, particularly NWRA, with respect to water resource management issues, while implementation of ground and surface water projects belongs to MAI. Licensing and permits for the construction of agricultural infrastructure and selection of site locations are part of the coordination.

The National Irrigation Programme was one of the sectors involved with both NWSSIP and WSSP.

The water law of 2002 and its accompanying by-law clarify the functions of MAI in water resource management as follows:

- Prepare policies and executive irrigation plans to derive maximum benefit from the agriculture sector's share of water.
- Conduct theoretical and applied studies and research; implement guidance programmes; take actions intended to rationalise water use so as to increase the productivity of water used for agricultural crops; and encourage the use of modern irrigation techniques where economically feasible, with water shares specified for irrigation so as to conserve water and protect the environment.
- Establish, operate and maintain water installations so as to benefit from rain and floods within the framework of the indicators of the water budget for water basins and zones, and the overall water plan.
- Draw up a plan for protection from floods; set up and operate an agricultural-climatic observation network, record and analyse the information observed and document, share them with the NWRA and with beneficiaries, and utilise the output of the national network for water observation.
- If any authority in the areas where there are users of irrigation water is exposed to the risks of rainfall and floods during their handling in the field, and if there is a risk of injury to life or property where the general interest dictates the adoption of urgent measures in that regard, MAI has the right to take whatever action it deems appropriate, including the destruction or breakage of any installation and removal or erection of any barrier within the narrowest limits that enable it to prevent or avoid such injuries. The Ministry shall pay fair compensation to beneficiaries upon any injury that causes such actions to be taken, within six months of their implementation.
- In this regard, the executive by-law determines the control of coordination among the Ministry, the Authority, and the other relevant bodies.
- Draw up and implement plans and programmes relating to the courses of valleys and public canals; monitor the flow of the rainfall and floods; monitor the use of irrigation water and its installations to ensure their safety, and preserve the water from waste and pollution.
- Prepare demand indicators on irrigation water in the short, medium, and long term, including the projected need of the private sector for irrigation water. After being reviewed and evaluated, the indicators will constitute one of the inputs to the water plans stipulated in accordance with the water law.
- Protect the soil, botanical cover, and vegetation, ensuring the ideal exploitation of water and land resources to secure natural environmental stability and mitigate the effects of erosion and other damaging human and natural factors.

- Maintain valleys and watercourses and protect them from erosion; construct facilities necessary to protect soil, public and private property, and population conglomerations, including eradicating Sabsaban trees.
- Protect and maintain agricultural terraces to minimise the power of flood flow and enhance rainfall water harvesting methods.
- Prohibit expansion of agricultural lands, civil and industrial installations or others on the expanse of water and flood courses and public channels, that would in any way hamper the flow of flood water into the channels constructed for that purpose; erection of barriers, buildings and other structure in areas prone to flooding, and construction of buildings between watercourses and structures erected for protection from floods. An exception to this stipulation would be a structure erected for the protection of adjacent buildings and properties in case of emergency.
- Demolish barriers, buildings, and any other structures that would hamper the flow of water or otherwise assist in increasing the damage caused by floods, upon payment of fair compensation to the owners.

Local government

Local government structure is covered by local authority law no. 4 of 2000.

The local authority law and its executive procedures and regulations were prepared prior to the water law of 2002. That law refers in many articles to the local authority law and to the local council for water resources management. The local authority law defines the functional responsibilities of local councils and local organs of line ministries in water

management, including NWRA branch offices. It forms the basis for the enhancement of decentralised integrated water management principles in the country.

The following are some important articles from the local authority law:

Article 19 states that the local provincial council is responsible for examining and approving projects of comprehensive provincial plans and for supervising their implementation, providing guidance, supervision and control over the work of local councils in districts and executive organs of the respective county.

Article 4. The local authority system, in accordance with the provisions of the Constitution and the law on the principle of administrative and financial decentralisation, based on the expansion of popular participation in decision-making and the management of local affairs in the areas of economic, social and cultural development through elected local councils and their authorities, shall propose programmes, plans and investment budgets for administrative units and exercise their role in the implementation of development plans and programmes in accordance with the provisions of this law. The authority system shall also ensure the people's oversight and supervision of the executive organs of local authority and accountability.

The work of local district councils and executive organs of the governorate includes responsibility for all activities relating to water resources, supervision and control of the implementation of the water policy, and protection of the watershed from depletion and pollution, in accordance with the relevant laws and regulations and the instructions from the pertinent central authorities.



Law no. 33, 2002, Water law and by-laws – Selected articles

Article 3

The goals of the law are: to develop and retain the extraction of water resources; protect water resources from depletion and pollution; improve the allocation of water and the operation and maintenance of water installations; and promote the participation of beneficiaries in managing, developing and conserving the water resources from which they benefit.

Article 6

All potential beneficiaries of any water resource shall enjoy the right to benefit from the relevant water resource provided that they do so in a manner not harmful to the interest of other beneficiaries and that they carry out all duties relating to the conservation and safeguarding of water resources. The Government regulates the rights and responsibilities of those from benefiting from such resources.

Article 10

Water users' and beneficiaries' associations may be formed for the purpose of involving water users in

managing water resources and/or in operating and maintaining water installations. More detailed rules governing such associations are included in the by-law of this water law.

Article 11

The National Water Resources Authority (NWRA), in collaboration with the relevant Authorities, is responsible for establishing water basin and water zone committees. These committees shall work under the supervision of the National Water Resources Authority.

Article 15

All government agencies, and private and public legal entities, shall submit their water projects to NWRA for review and approval.

Article 17

NWRA shall formulate the foundation for water planning in Yemen based on assessment of the water basins and water zones, general indicators of the water situation in the country, trends in long-term demand for all types of water use, and the water budget.

Article 20

The law established priorities for the use of water. The highest priority is given to water for drinking and domestic purposes.

Article 27

The right to make use of water entitles the holder to use water in a way that does not conflict with the public interest or with the prevailing customs and tradition in each area or water basin. In all cases, existing and acquired rights to water, whether before or after the issuance of this law, are protected and are not affected except for in cases of utmost necessity and with fair compensation.

Article 28

The traditional right to benefit from the rain harvest and the naturally flowing flood water shall be respected.

Article 29

Traditional usufruct rights existing prior to the issuance of this law shall pertain to the water of springs, natural streams, and shallow wells whose depth does not exceed 60 metres, which shall be preserved, and their owners shall retain them as existing rights without prejudice to the rules of registration, provided the resource is used specifically for the purposes for which it was intended. If transferred to the ownership of others, these rights are obligatorily transferred to the new owner. In the case of fragmentation of the land benefiting from water, the water shall be distributed according to the areas of the plots of land resulting from such fragmentation.

Article 30

Without prejudice to the provisions of water-protected zones, it is permissible to obtain quantities of water in tanks, or ponds through direct collection of rainwater from the land or installations owned by the beneficiary, or from the areas adjacent thereto, which transfers the right to benefit from the rainwater collected.

Article 31

The executive regulation of this law determines the cases in which the State may appropriate the right to use water, if the public interest so requires, or the need to rationalise the use of water, with fair

compensation to the beneficiaries in accordance with the laws in force.

Article 32

In accordance with articles 28-29 of this law, owners of the usufruct rights must apply to the Authority to register those rights within a maximum period of three years from the date of the announcement made by the Authority after the issuance of this law.

Article 33

Beneficiaries (or their representatives) of the groundwater wells drilled prior to issuance of this law, and owners of the usufruct rights attached thereto, whether such rights are exercised or not, must apply to NWRA or one of its branches in the governorate offices and directorate centres for registration, and exercise the continuation of their usufruct rights and agreement within three years from the date of the announcement by the Authority after the issuance of this law.

Article 34

The Authority and all its branches shall keep a register of all usufruct rights over water, and shall explain the system and rules for keeping this register and the registration procedures and amendments thereto.

Articles 35 and 36

No individual, group, or entity of the Government may dig water wells or build water installations designed to hold back water without the appropriate permit issued by National Water Resources Authority (NWRA).

Article 42

The following activities cannot be undertaken without prior permission from the National Water Resources Authority: drilling water wells, exploring for groundwater, or distributing water drawn from water wells through private supply networks or by bottling.

Article 48

The Government, acting through the National Water Resources Authority, shall undertake the following tasks: providing support and facilities to farmers; encouraging them to adopt modern irrigation methods aimed at using water more efficiently; building dams; dikes, and reservoirs to make optimum use of rainwater; providing such services as soil conservation

and vegetative cover to conserve water; and supporting and encouraging community participation in the management and conservation of water resources.

Article 49

In some circumstances, based on a proposal from the National Water Resources Authority, the Council of Ministers may prohibit the construction of any structure or the development of any industrial, agricultural, or other activity that could increase the burden on water resource reserves in a specific region.

Article 54

The National Water Resources Authority has the power to protect water resources against pollution; maintain water quality; prevent activities that may lead to pollution or degradation of water quality; and formulate procedures for regulating potentially polluting activities.

Articles 61 and 62

The Ministry of Agriculture and Irrigation and other relevant authorities are responsible for flood control activities and policies. Beneficiaries from torrential water and those who own agricultural land or facilities adjacent to its streams shall contribute to protect their properties and regulate water courses that they benefit from.

Articles 63 and 64

Staff members of the National Water Resources Authority have the status of judicial enforcement officers. They are responsible for enforcing the water law and regulations and for reporting violations.

Article 77

The National Water Resources Authority may collect fees, charges, and deposits for the permits it issues and the technical services it renders. Details are provided in the by-law.

The objective of these points is to support the Government in reaching its goals, as mentioned in article 3 of the water law. In addition, it aims to support the responsible water authorities in finding and solving water problems in the country by taking necessary and correct decisions in organising, managing, developing, and protecting water resources from exploitation and pollution. This includes appropriate and effective methods to be implemented

so as to achieve integrated water resources management using a participatory approach.

Executive by-law of the Yemeni water law: Water rights and licenses

Chapter One. Water rights

Article 27

The right to make use of water entitles the holder to use water in a manner that does not conflict with the public interest or with the prevailing customs and traditions in each area or water basin.

First - Usufruct rights controls.

1. The usufruct right must be based on a water resource known by its name, location and area, or defined by land and geographical boundaries and features that are known and identified in the usufruct certificate, or in the traditional inherited or transferred rights documents.
2. If groundwater appears during the implementation of work on any privately or publicly owned land, and if that work was not intended to legally extract water, the owner of the land or its tenant, or a partner in it, must notify the Authority in writing within a period not exceeding one month. It may not be used by any natural or legal person without the approval of the Authority and in accordance with the law and the provisions of these regulations.
3. The right to use existing water before or after issuance of the law shall not be established except after verifying its legitimacy, registration and compliance with the law, and after the beneficiary obtains an approved registration certificate from the Authority in accordance with the provisions of this regulation and the system prepared by the Authority for that purpose.
4. In order to enjoy the right to use water, that right must be proven in one of the following ways:
 - a A usufruct certificate issued by the Authority for the right of usufruct acquired after issuance of the law and in accordance with the provisions of this regulation.
 - b The presence of the name of the beneficiary on the list of beneficiaries of water projects set up by the competent authorities, or

- public or private projects licensed in accordance with the provisions of the law and these regulations, provided that the beneficiary brings a certificate from this Authority proving his right to use water on the responsibility of the authority issuing the certificate.
- c Evidence documents submitted by the beneficiary of the right to benefit from a specific water source, certified by the competent court.
 - d The testimony of two fair witnesses who benefit from water from the same source, certified by both the local council and the competent court, provided that the two witnesses have reached the age of majority and are known to have full knowledge of the water rights to this source.
5. If any beneficiary submits a written objection to the right of usufruct of other beneficiaries, the procedure shall be as follows:
 - a The objection shall not be accepted in form unless the objector is one of the beneficiaries of the original or associated rights with water from the same water source as the object of the objection.
 - b The objection shall not be accepted in content unless one of the conditions identified in paragraph 3, above, pertains.
 - c To avoid confusion over any developments, the right of usufruct shall not be established for any of the objectors except by a final and enforceable ruling by the competent court.
 - d The person registered on the list of beneficiaries of the projects identified in paragraph 5-b, above, is treated as a beneficiary only, and does not have usufruct rights over the same water source, unless he is one of the owners of the original usufruct rights over that source.
 6. The Authority may determine the total quantity that may be used from each surface or underground water source or from each water facility separately, within the quantitative limits that would meet basic needs, and may maintain the sustainability of water sources and the fairness of their use, taking into account the following:
 - a With respect to water projects of collective benefit set up by government agencies, or public or private projects as legal persons benefiting from the rights of public or common original water, or belonging to the group of original beneficiaries of the source or sources of water on which the projects are based, the pertinent provisions of this regulation apply to each of them.
 - b The authority concerned with managing, operating and maintaining water facilities projects shall determine the quantities that individual beneficiaries are allowed to extract water from the facilities in accordance with their own systems, provided that they do not exceed the total quantities of water previously allocated to them from these projects and facilities.
 - c In the event that it is necessary to reallocate water on existing usufruct rights, for reasons related to water scarcity, or to allocate part of it for drinking purposes and domestic uses, the beneficiary or beneficiaries must commit to using the quantities of water that have been reallocated to them, and are not entitled to expand into new uses except with a license from the Authority.
 - d The beneficiary of a right to use water from any water source shall not be compensated for the quantities of water reallocated, provided that the remaining quantities are sufficient to meet the water use right for the purpose specified prior to the reallocation, or the remaining quantity meets the purpose of use in proportion with new ways and methods of use imposed for the purposes of rationalising water.
 - e The beneficiary shall be fairly compensated in cases where he is deprived of the right of usufruct solely because of the reallocation of water, whatever the reasons for the reallocation.

- f In cases where the beneficiary has acquired a legitimate usufruct right over a specific water source, and this has resulted in the establishment of economic or social structures that are not subject to change and compensation, and after all the required rationalisation and legalisation measures have been taken, the owners of the new usufruct rights must accept the Authority's decision in either of the following two cases:
 - i Satisfying new requests, in part, when the water source is able to provide a surplus of water that exceeds the need of the previous beneficiary.
 - ii Refusal to accept new requests, when it is not possible to supply surplus water from this source to meet any new request.
 - g Usufruct rights shall be considered void and without compensation if any of the water sources on which these rights are based dries up due to natural causes.
- c Establishing water and sanitation facilities and projects, and water treatment plants, in the public interest, on land used for rainwater harvesting, provided that the owners of usufruct rights for harvesting water from this land are compensated with water from the same facilities and projects, or other fair compensation commensurate with the extent of the damages caused to the beneficiaries.
2. The right to irrigate with flood water flowing naturally through channels developed prior to the issuance of the law shall be dedicated to irrigating the agricultural land for which those channels were built, and they shall be managed according to the irrigation systems and controls prepared for the purpose.
 3. The usufruct rights to rain-harvested water and naturally flowing torrents are taken into consideration, provided that this water is used to irrigate the agricultural lands allocated to it. The usufruct rights will not necessarily be taken into consideration if any of the land or water is transferred to other benefits and purposes, contrary to the provisions of the water law and these regulations.
 4. It is not permissible to transfer the ownership of traditional usufruct rights to the water harvested from rain and floods separately from the agricultural land that benefits from it, unless that land no longer needs water. When ownership of the land is transferred or sold, the right to use the water shall be maintained. In the event of division of the land benefiting from the water, the water shall be distributed according to the areas of the plots resulting from the division.
 5. It is not permissible to divert or transfer water harvested from rain and floods to other areas or locations, except after taking traditional usufruct rights into account, so that the transfer or transfer operations take place after the beneficiaries' approval or their assignment in writing, without prejudice to the right of fair compensation to those affected.

Article 28

Traditional rights to benefit from harvesting rainwater and naturally flowing torrents shall be taken into account, with regard to its use in irrigation and its connection to the agricultural land benefiting from it. These rights shall take into account the characteristics of the areas related to customs, traditions and irrigation systems observed and recognised in each region of the Republic, and in accordance with the following controls:

1. Traditional usufruct rights based on harvesting rainwater and naturally flowing torrents may not conflict with the development and protection of water resources, or the procedures for managing them in general, especially in the following areas:
 - a Protecting and preserving surface and ground water sources with the necessary monitoring, inspection, investigation, study and exploration procedures, as well as constructing the necessary facilities.
 - b Establishing water storage and drainage facilities, irrigation systems, and modernising and developing irrigation and water

6. Rights to benefit from the surplus water harvested by rain and flood flowing through their original natural courses shall remain as they were prior to the issuance of the law, and may be used for other purposes required by the public interest.

Article 29

Traditional usufruct rights, and the rights attached thereto prior to the issuance of the law, over the waters of springs, gorges, natural streams and wells shall be preserved, and their owners shall keep them without prejudice to the rules of registration, provided that they remain designated for the purposes for which they were intended. In the event that they are transferred to others, these rights shall obligatorily be transferred to the new owner. In the case of division of the land benefiting from the water, the water shall be distributed according to the areas of the plots resulting from the division.

Article 30

Without prejudice to the provisions regarding protection zones and water confinement, it shall be permissible to obtain quantities of water in tanks, ponds, or boilers, through the direct collection of rainwater from lands or facilities owned by the beneficiary, or from the areas adjacent thereto, entitling the beneficiary to benefit from the water collected. Rainwater and its acquisition are considered acquired usufructs, provided they do not harm previous benefits and do not conflict with the water rights acquired in accordance with established norms and traditions related to the rights to benefit from rainwater. The beneficiary may establish such irrigation facilities as are necessary to benefit from the water collected. He may also construct branch channels according to the following procedures and controls:

1. The original beneficiaries, or others authorised by them in writing, may acquire a quantity not exceeding 500 cubic metres of rainwater without prior licenses, whether for individual, family or collective use.
2. None of the partners benefiting from rainwater that collects from areas of common land shall have the right to acquire this water alone or with the participation of certain partners while excluding others, unless the consent of all the partners benefiting from such water has been obtained.

3. Water shall be acquired, sequestered or stored with the aim of using it for the usual purposes, or for any of the beneficial purposes consistent with the priorities of water use.

4. If there are multiple beneficiaries of rainwater collected in an area of common land, or for common benefit, the quantity of water obtained shall be shared among the beneficiaries, unless otherwise agreed in writing.

5. If the land is of common interest, and the right to use the water on it is allocated, or vice versa, the following shall apply:

- a. If both the land and the usufruct rights of the combined water are owned and are common, then all beneficiaries of the water and the land are considered partners in the use of the water, according to agreed shares and with the approval of the local council.

- b. If the usufruct of the water collected on common land is allocated to a natural or legal person, then no consideration shall be given to the communal usufruct of the land, and the usufruct right over the water shall remain the basis in any dispute.

- c. The right of usufruct over common water that has not previously been used shall not be acquired until after obtaining written approval from the local council.

- d. If the ownership of the common land is transferred to private ownership, the right to use water collected by this land shall remain as it was prior to the transfer of ownership.

6. The right to use the land and rainwater it collects shall be maintained, and if the new acquisition of water would bring about changes that limit or prevent the use of these rights, then equal compensation shall be made for them, with the proviso that it is not permissible to change the situation recognised by Sharia or custom, except by a decision of the competent court.

7. The right of passage for machinery, equipment and domestic animals, or the construction of channels and service facilities benefiting from the water obtained, shall not be acquired once the water is obtained when such actions would harm the interests of others; the beneficiary must either obtain prior consent from the affected parties, or compensate them in kind or in cash, or by any means they accept by mutual consent, or through the competent authorities and courts, and in accordance with the laws in force.
8. Temporary lease contracts are not valid for transferring water in channels and sewers through the lands of others, and when there are no other options available, the competent authority shall decide whether or not to obligate the landlord to allow the passage of water through his land, and propose appropriate compensation.
9. If the owners of the land, who are at the same time holders of the right to benefit from rainwater harvesting from the land agree, then each of them shall be obligated to allow water to flow over their land to the specified location for water use; and if there is a need to use other land to transport or store the water, the beneficiary must obtain approval before undertaking the work.
10. If a dispute arises concerning the size of storage facilities or the direction of water courses, a body with recognised professional experience shall be delegated to decide the necessary design standards for water utilisation. If the dispute persists, the two parties, together or separately, shall have the right to resort to the competent court.
11. The authorisation or authorisations must be in writing and issued by the competent court.
12. The Authority, in coordination with the local council and the relevant local authority, may prevent the establishment or removal of any facilities installed to benefit from rainwater harvesting in the following cases:
 - a If the beneficiary exceeds the volume of water specified in this article, without a license, or if it would cause serious disputes among stakeholders.
 - b If the beneficiary causes significant harm to the environment or to important public interests.
13. The quantities of water obtained in accordance with the provisions of this article shall be subject to rationalisation and reallocation.

Article 31

The State may appropriate the rights to use water if the public interest so requires, or in case of necessity to rationalise water use, with fair compensation to the beneficiaries in accordance with the laws in force, while complying with the following conditions and controls:

1. Usufruct rights for the public interest may be revoked, temporarily or permanently, with compensation:
 - a If there is an urgent need for drinking water and water for household uses.
 - b If the usufruct rights are based on a water resource used for agriculture, and the resource is located in an area designated for the purpose of protecting national security.
 - c For the purposes of study and scientific research, or to protect the health of the population, preserve the environment, or relieve the pressure on groundwater.
2. The State may appropriate usufruct rights, in whole or in part, and without compensation, if:
 - a The usufruct owner knowingly sells, permits the beneficiary to use, or waives his right to use the water for purposes harmful to national security.
 - b The beneficiary abandons his right, without an acceptable reason, for a period exceeding five years.
 - c The usufruct right is based on a common water source or a concession or lease contract for a temporary period, then that period expires without renewal, or if the usufruct right forfeits after this period.

- d The beneficiary repeatedly fails to comply with the terms and conditions of the usufruct rights and the directives of the Authority.
 - e It is found that the water used is not usable for the purposes specified.
 - f The beneficiary uses the water for useless or unauthorised purposes.
 - g The beneficiary transports water in large quantities from its area, and uses it in areas outside the basin without a prior license; or if the beneficiary speculates in water, or sells it, which is physical evidence that he has more water than he needs, the Authority may adjust the quantities of water authorised to him and transfer the surplus to the State without compensation.
 - h It is proven that the beneficiary of the water has intentionally and repeatedly wasted or misused it, without complying with the limitations pertaining thereto.
 - i The beneficiary refuses to pay the fees resulting from the right of usufruct in accordance with the law and the laws in force.
3. In accordance with the provisions of Article 40 of the law, and without prejudice to any other provisions, the Authority may suspend the right to use water permanently or temporarily, from any wells or water installations, pursuant to a decision of the Minister based on a proposal from the Chairman of the Authority, in the following cases and in accordance with the following controls:

First: The decision to suspend the right to use water permanently or temporarily due to pollution shall be accompanied by justifications based on a report in the following cases:

- 4. If it becomes clear that the water is polluted and harms public and environmental health, and it is impossible to treat the pollution, the right of usufruct shall be suspended permanently.
- 5. If it is possible to treat the water pollution, the right of usufruct shall be suspended for the period that the Authority deems necessary to treat the causes of pollution and restore water quality.

Second: In the event of the discovery or reporting of sudden pollution incident, the decision to suspend shall be taken without waiting for the laboratory report, provided that the decision is confirmed or cancelled after receiving the report.

Third: In the event of pollution occurring due to natural causes, the decision to suspend without compensation shall be taken.

Fourth: If it turns out that the pollution was created intentionally or unintentionally, the following decisions and measures shall be taken:

- a A decision shall be taken to suspend the right of usufruct without compensation, if the person causing the pollution is the same beneficiary, without prejudice to any more severe penalties in accordance with the law and its legislative references.
 - b The person causing the pollution shall be referred to public prosecution as soon as it is confirmed that the pollution has been discovered or reported by any legal or natural person.
6. Without prejudice to any other penalties or other measures, the Authority may reconsider or amend the usufruct right, or postpone its registration until the legal situation is corrected, in the following cases:
- a If it is proven that the beneficiary submitted incorrect data to the Authority, and the license or registration was issued on the basis of that information.
 - b If the beneficiary violates one of the technical conditions or fails to comply with the obligations contained in the drilling license or in the construction of water facilities.
 - c If the beneficiary uses the water for a purpose other than that specified in the license or registration certificate granted by the Authority.
 - d If fraud or forgery occurred during legalisation of the use or sale of water, or assignment of the right of usufruct to others, and if the quality of the water and the authorised purposes of its use were not made public.

Article 32

The Authority and all its branches shall keep a register of water use rights, and shall prepare the system and rules for maintaining this register, the procedure for registration and its amendments, according to the following principles:

A. Procedures for registering water use rights.

1. The Authority shall prepare a standard, unified official application form for all beneficiaries of water rights. The beneficiary shall complete and sign it and have it certified, and it shall then be submitted to the Authority. Only applications on the original of the form will be accepted.
2. The application form shall contain the following information and data:
 - a. The name or names of the triple beneficiaries, their titles, areas of residence and personal card numbers.
 - b. The type of usufruct right (acquired, inherited, endowed, common, etc.), the rights attached to the usufruct right, and the purposes for which it is used.
 - c. The location of the usufruct, the type of ownership of the site, its name, area and geographical boundaries.
 - d. The number of original beneficiaries, partners and other holders of subordinate rights.
 - e. The date of submission of the application and the signature of the owner.
 - f. Any other required information.

There should be enough space on the application form to accommodate a certificate from the court or competent authority of the confirmation and accreditation of the usufruct right.

3. The Authority shall not process the application until the beneficiary has completed all the information on the application form, paid the application fee prescribed in accordance with the provisions of these regulations, and obtained a

receipt to accompany the application, in addition to attesting and certifying the application with the authorities indicated on the form.

4. The right of usufruct shall not be established until the beneficiary has attached all the requisite documents, approved by the competent courts in same area where the water source is located, and the usufruct right upon which the registration request is based.
5. The Authority shall examine the applications and their attachments, and will not accept copies of any of the documents submitted to it to establish the right of usufruct until they have been certified in true form by the competent authorities, and after reviewing the originals of the documents or receiving a definitive ruling validating them from the competent court.
6. Registration applications shall be submitted separately for each usufruct. Application for the registration of a usufruct on more than one water source shall not be submitted on one application form unless the right is shared by more than one beneficiary.
7. The Authority shall register the application in its official records and issue a receipt to the beneficiary indicating that the application has been received and including the date of obtaining a certificate of registration of the usufruct right. In the event of additional inquiries, the Authority shall notify the beneficiary within the period indicated in paragraph B, below, of this article.
8. In the event that the beneficiary is unable to submit all the documents required to prove his right to usufruct, or in case of suspicion of the existence of original or subordinate rights to a third party over a common water source, the Authority shall announce this through government newspapers, and at the beneficiary's expense, stating that the right of objection is available for a period of thirty days from the date the advertisement. After that period, the authority shall have the right to decide on the application for registration, no objections will be accepted, and those affected must apply to the judiciary.

9. The Authority shall verify the location of the water source subject of the usufruct registration request, and may investigate other usufruct and easement rights, in addition to distributing a site announcement that includes the name of the beneficiary and the subject of the registration request, providing a deadline of not more than one month within which those who have the right to object may apply to the Authority.
 10. Such advertisement published by the beneficiary alone will not be accepted, unless the advertisement is prepared and approved by the Authority.
 11. The Authority shall suffer no material consequences or legal responsibility for deciding on the applications it receives, after completing the procedures set forth above, provided that this does not cancel the right of those affected to apply to the judiciary.
- B. The Authority shall complete the procedures for registering the application and issuing the registration certificate as follows:
1. Each application shall be identified by a serial number, and proofs of registration shall be maintained in a special register, classified according to basins and water areas, so that the registration number corresponds to that shown on the application.
 2. Examination and completion of the procedures related to acceptance or rejection of the application shall conclude within a period not exceeding thirty days from the date of receipt. In the event of acceptance, the Authority shall issue the registration certificate within a period not exceeding thirty days after expiration of the period of advertisement in government newspapers or on-site advertising.
 3. The Authority shall prepare a standard, official registration certificate, bearing the serial numbers and including the information contained in the application.
 4. The Authority shall issue registration certificates bearing the names of specialists, certified and stamped by the head of the Authority, shall keep copies of them, and shall document them in the official water rights register.
5. The Authority shall mark the applications that have been rejected and those that have been accepted and for which registration certificates have been issued, indicating the date of each.
6. The Authority shall maintain the applications and the documents attached thereto in a safe place, so that only specialists are allowed to access them, provided that the Authority determines the names of the specialists and the limits of their responsibilities and powers related to handling and keeping these documents, so that:
- a. No person who is not a specialist has the right to view the application and the documents attached thereto, or to circulate them except on the basis of a final and enforceable ruling from the competent courts, or upon an official request from the public prosecutor's office.
 - b. Neither specialists nor non-specialists are entitled to replace or make any deletion or addition of any kind to any document, except based on a final and enforceable ruling from the competent courts.
 - c. Specialists may not transfer documents from one location to another, or change the means of their preservation, except upon a written order from the head of the Authority.
7. The Authority shall issue a replacement document for a concerned person who has mislaid his usufruct documents or certificate, based on an official report prepared by the police department and ratified by the local council and the competent court in the usufruct area, without any change in the information and data contained in the documents maintained by the Authority.
- C. The Authority may refuse or postpone the decision concerning the registration application in the following cases:
1. If it finds that the documents evidencing the right of usufruct are not serious or sufficient, if they are incorrect or if the information they contain is incorrect.

2. In the event of doubt about the methods of acquiring usufruct rights, the Authority may postpone the decision concerning the application until sufficient assurances become available to enable it to make the right decision.
- D. The applicant shall pay the costs of services and registration fees in accordance with the system attached to this regulation and prepared for that purpose, as follows:
1. Advertising costs in official newspapers, including delivery to the press and follow-up upon publication. The role of the Authority is limited to drafting and writing the advertisement and delivering it to the beneficiary only.
 2. The cost of preparing and completing the registration certificate, including the cost of field verification of the usufruct.
 3. One-time registration application fee upon issuance of the registration certificate.
 4. The fee prescribed for the right to use water for commercial use.
 5. The fee prescribed for the protection of water resources.
- E. The water rights registry shall be standard and uniform in all regions of the Republic.
- F. In cases where water resources are not able to meet all the usufruct, the Authority may:
1. Obligate more than one beneficiary to jointly benefit from one or more water sources, if the Authority deems that this will achieve the public interest, rationalise the use of water or meet the interests of the beneficiaries.
 2. Gradually reduce the quantities of water that the beneficiary is entitled to extract, following a review and reallocation of water within the framework of the water resources management plan.
 3. Charge fees for water use rights, according to procedures that comply with applicable laws.
4. Review and reregister water use rights, whether in all regions of the Republic or in a specific basin or water area, provided that the period between registration and reregistration is not less than five years.
- G. In a manner that does not conflict with the provisions of this regulation, the Authority shall prepare an executive system for implementing the provisions of this chapter, and a decision shall be issued by the Minister based on a proposal submitted by the head of the Authority.

Chapter Two. Licenses

Article 33

Subject to the provisions of Articles 29, 30, 35, 36, 38, 39, 40, 45 and 73 of this law, the following must be adhered to:

- A. It is not permissible for any individual, group, governmental or private entity, or any legal or natural person, to drill any water well or establish any water installation to control the waters of torrential streams in valleys and water basins or under their surface, or to divert them from their natural courses, except after obtaining a prior license to do so from the Authority.
- B. No beneficiary may exceed the quantities, purposes of use, or any other technical specification determined by the Authority, and all must comply with the conditions specified in the license.
- C. The Authority shall carry out all procedures that would implement the provisions of the above-mentioned articles, preparing and issuing licenses for drilling and deepening wells and constructing water facilities in accordance with the following procedures:

First: System for submitting licenses applications.

1. Preparation of unified official standard application forms for all regions of the Republic, with serial numbers for each water basin separately, bearing the name of the Ministry and the Authority, and including the necessary data and information, particularly the following:

- a The license applicant's name, surname, nationality, fixed address, personal or family card number or passport number, and the date and signature of the application, provided that government agencies are excluded from the data related to the card or passport.
 - b The location, region, directorate and governorate of the work specified in the license application form, and its geographical boundaries.
 - c The purpose of digging a well or establishing a water facility, the volume of water required and the purposes of its use.
 - d The type of work required (drilling a new well, deepening a previously drilled well, establishing a new water facility, replacing or modernising an old facility, etc.).
 - e A statement of the nature of the ownership of the well or facility to be licensed, the previous water rights or those resulting from drilling the well, and the number of partners in these rights or beneficiaries of them, if any.
 - f The authorities must approve, deliberate or confirm that they do not object to the request, provided that they are the competent authorities present in the work area and the subject of the license requested by the beneficiary, in particular the local council and the institutions and bodies related to water and sanitation projects.
2. The beneficiary shall complete and submit an application on the standard form mentioned above, to obtain a license to engage in any of the activities enumerated in this article, provided that the beneficiary abides by the following:
 - a Submit the application in his full name and sign it on his own behalf; if he is deputising for someone else, he must bring written authorisation from the original beneficiary, certified by the local council in his area.
 - b Complete the confirmations indicated on the license application form, taking into account the privacy of requests submitted by government agencies or projects of public interest.
 - c Submit the request to the Authority or its competent offices in the governorates, or to any of the authorities officially authorised by the Authority to accept it, in the administrative region in which the work site to be licensed is located.
 - d Attach a document proving ownership of the work site, certified by the competent court in the requested work area. If it is not possible to prove ownership in this way, two notary certificates from the owners adjacent to the drilling site or water facility must be attached to confirm ownership of the site, certified by the competent court in the administrative region in which the site is located.
 - e Attach the partnership document or the partners' authorisation, indicating the number of original beneficiaries and owners of the associated rights, authorised by the competent court in the administrative region in which the work site is located.
 - f If the application is for an investment project, the technical study and the project document must be attached, with a letter addressed to the authority from the General Investment Authority, or the approval of the Ministry of Planning and International Cooperation to support the beneficiary's request. If it is for an individual project with limited water consumption, the technical study of the project shall be attached as necessary and in accordance with the requirements for each individual case.
 - g No statement or certificate to prove or deny the beneficiary's right to request shall be accepted from any party outside the administrative area of the application site, whether local councils, official or private bodies, or others.
 3. The Authority shall not accept copies of any documents, although it may accept certified true copies of documents by an official body and with the knowledge of the competent court, provided that both share responsibility.
 4. Requests for deepening wells, or modifying or introducing additions to water installations previously licensed by the Authority, shall not

require new documents to prove ownership, provided that the applicant submits a confirmation by an official body that proves that there have been no developments that contradict the data and information provided earlier. This shall have been included in the documents previously submitted to the Authority, under which the previous license was issued.

Second: Procedures and controls for accepting applications.

A. Requests from non-governmental organisations.

Applications are not officially accepted until the Authority has studied them in accordance with the provisions of this article, and ensured that the applicant fulfils the conditions for submitting the application, as well as investigating usufruct rights over the water resources, in particular the following:

1. Announcing by visual, audio and print media as necessary, including distributing a website announcement that includes the name and location of the license applicant, the subject of the application, and any other data, and giving a period of no less than two weeks for those who have a right to object to submit their objections to the Authority. The State's major strategic projects are to be excluded from the declaration.
2. Ensuring that the water rights, the type of site ownership and the purposes of water use match the request data, and ensuring that the request does not conflict with the provisions of decisions related to the protection areas and the water quarantine.
3. Ensuring that the capabilities of water sources meet the new demand; the extent to which water priorities for drinking, domestic uses, and potential purposes of water uses at the demand site are affected; and consistency with the sustainability of water resources.
4. Ensuring the validity of the site and the technical standards for drilling wells and constructing water facilities, upon submission by the beneficiary of studies or ready-made designs with the request.

5. The beneficiary shall provide financial guarantees, and pay fees and service charges in accordance with the provisions of these regulations.
6. The beneficiary must submit a written undertaking, certified by the local council and the competent court, confirming the following:
 - a Adherence to the conditions, controls and standards that entitle him to obtain a work permit, especially taking into account the water and environmental conditions, so as to allow the Authority's employees to ensure the safety of carrying out the licensed work, as well as to monitor the purposes and quantities of water used, periodically or whenever necessary.
 - b Acceptance of relinquishing financial guarantees in favour of the Authority when it is proven that the beneficiary has violated the terms and conditions that necessitated the payment of those guarantees, and paying any other penalties in accordance with the provisions of the law.
 - c Commitment not to contract for drilling wells or establishing a water facility with companies or contractors who have not obtained licenses and certificates from the Authority to practice the profession.

B. Requests from government agencies.

Without prejudice to the provisions of this regulation, the Authority shall accept requests from government agencies to obtain licenses that include some or all of the work included in their previously approved plans and projects without the assurances or guarantees set forth above, provided that the Authority coordinates with local councils, basin committees and relevant government agencies to ensure that:

1. The required amount of water does not prejudice the water quotas indicated in the water plan or designated for specific projects or use purposes. It cannot be provided from another source of water that is currently available, or within the next six months.

2. The required work or the required water does not interfere with the plans and projects of those entities, or other usufructs.
3. The new demand is in line with the path of viable investment alternatives in current and future water-based development plans.
4. The requests of government agencies constitute some or all of the work previously approved in the sectoral plans or the water plan.

C In addition to the terms and conditions set forth in these regulations, and without prejudice to other provisions, the Authority shall observe the following:

1. Applications may be accepted without the need for a technical study or an investment project, in the event of a request to invest water in quantities not exceeding 15 liters per second from groundwater, or a total quantity not exceeding 500 cubic metres per year of water stored in dams or that can be transferred through the flood and rainwater harvesting channels.
2. Studies and water information that are more than ten years old shall not be considered.
3. In the event of an objection by a beneficiary or beneficiaries of water rights or the rights attached thereto, the objector must prove the right of objection through the competent courts or through conciliation, provided that the decision on the request is postponed until the reasons for the objection are removed.

D. To ensure the correctness of the data and information contained in the application, the Authority shall prepare a report on the water conditions, economic and social activities and water rights related to the applications submitted to it, so that:

1. Reports are prepared on a standardised technical report form for all basins and regions of the Republic.
2. The competent departments or sections of the Authority or its branches fill out the report in the office or in the field, or both, and it is then submitted to the head of the Authority, or according to specialisation, to the director of the

Authority's branch in the basin or water area in which the location of the application specified in the license is located.

Third: Procedures for registering applications and issuing licenses.

A The procedures for registering applications and issuing licenses are as follows:

1. Applications submitted shall be registered according to their serial numbers and dates of submission, in a special entry classified by regions and water basins.
2. The Authority shall prepare licenses for drilling wells and constructing water facilities on its official forms, within a period of sixty days from the date of submission of the relevant applications. The licenses are issued following the approval of the basin committee, if any.
3. The Authority shall not issue a license to dig wells or establish water facilities in drained basins until the beneficiary has installed of a metre to measure the quantities of water from the well licensed to be drilled, or has constructed channels for water drainage networks from the licensed water facility. In all cases, the license shall be issued only after the beneficiary has established his rights by submitting the financial guarantees indicated in the case, paying fees for services and other fees owed to the Authority and local councils, and signing and certifying, in writing, the undertaking indicated above.
4. The license shall not be considered an acknowledgment of a right to use water until the beneficiary has completed of all the licensed work and registered the usufruct of his well or facility within a maximum period of three months after completion of such work. He shall be entitled to benefit from the right of use after fifteen days from submission of the request for registration, in accordance with the provisions of these regulations.
5. The Authority shall estimate the beneficiary's need for water based on all or some of the following criteria:

- a The area of land irrigated prior to the request for drilling or deepening the well, or the numbers of the beneficiary population and the per-capita share of water for drinking water, household uses, mosques and tourism, or standard quantities in various industries.
- b Water sources as auxiliary sources, whether for supplementary irrigation or for drinking water projects, and inherited or acquired water rights, taking into account the fair use of water available to all holders of legitimate usufruct rights.

The Authority may estimate the beneficiary's need for water according to the climatic and rainy seasons, especially with respect to using groundwater for irrigation.

- 6. The Authority has the right to refuse to issue licenses in the following cases:
 - a If the beneficiary provides information that has been proven incorrect and if there are indications of harm to water sources and the environment, if others make valid objections, or if the beneficiary fails to comply with the required obligations and undertakings.
 - b If the beneficiary refuses to pay financial guarantees, fees, etc.
- 7. The Authority shall notify the beneficiary of a decision to reject his application, including the reason for rejection.
- 8. The beneficiary has the right to appeal the decision of the basin committee or the Authority to the head of the Authority or basin committee, and if not satisfied with that decision, he has the right to appeal to the competent courts to consider the case in accordance with the provisions of the law and these regulations, and the Authority must defend its decision. The Authority and the beneficiary may appeal to the courts of first instance, and the resulting judgment shall be final and binding.
- 9. The duration of a license to drill a well is six months, and of a water facility one year from the date of issuance. The license may be renewed once for periods of three and six months, respectively, which period may be extended if justifiable reasons are provided.
- 10. The Authority has the right to review licenses periodically, and it may adjust the depths of drilling wells before or during implementation or stop it at a certain depth, if the continuation of drilling leads to the mixing of groundwater with undesirable water layers, or if it becomes clear during drilling that permanent streams and springs have been damaged.
- 11. The small area of agricultural holdings or the small number of beneficiaries of water used for drinking, industrial, touristic and other purposes, in comparison to the quantities of water that can be extracted from a well or water facility, shall determine the Authority's position on granting or refusing a license. The Authority has the right to obligate the beneficiary to participate with others in digging a well or establishing a water facility for the joint use of water, as a condition for accepting the request to issue a license. The Authority also has the right not to grant a license to drill a well for the purposes of irrigating agricultural land with an area of less than half a hectare.
- 12. The authority may ask the beneficiaries, whether they are government agencies and projects or individuals, to redesign or correct the design of drilling wells and water facilities, or to do so on its own in the case of individual beneficiaries, in a manner consistent with water conditions and tangible water rights. Such a request shall be binding, and the beneficiary must take the necessary measures.
- 13. The distance between one well and another shall be determined by a decision from the Authority in line with the results of the studies carried out. In unstudied areas, the water conditions in each area shall be taken into account, ensuring that this distance is not less than five hundred metres in the main basins, provided that:
 - a The principle of participation in the rights to use water from new wells whenever the water situation is appropriate, as a condition for the approval of the Authority to accept the application and issue of a drilling license.
 - b The principle of consensus on participation between the beneficiaries of wells drilled before the application of the provisions of

- this regulation, shall take into account the legal principle (harm or no harm) and include payment of appropriate compensation to the well owners.
- c The limits of agricultural holdings that are subject to the provision of paragraph 11, above.
 - d Water well yield, so that the hectare share is not less than half a litre per second during the seasonal crop cycle, or during the year for annual crops and perennial trees.
14. The following wells are not subject to the distance condition stipulated in paragraph 13, above:
- a Wells designated for scientific research and for monitoring groundwater levels and quality.
 - b Wells located in subsidiary valleys and non-main basins, or that are not subject to the provisions of other protection laws or decisions.
 - c Wells whose purpose is to serve national security.
15. It is not permissible to issue a new or alternative well drilling license or a license to deepen an existing well in areas where springs are located unless the following conditions are met:
- a The location required to dig the well from the nearest spring must be at least 1,000 metres away from the possible course of the spring.
 - b The license applicant submits a written undertaking not to object to any decision taken by the Authority subsequent to issuance of the license, to amend the quantities of water allowed to be extracted in a manner that would not negatively affect the rate of water discharge from the spring.
 - c If it is proven that the well has a detrimental effect on the discharge of the spring, the license shall be cancelled and the necessary measures shall be taken to fill in the well, by
 - a decision of the Minister based on the presentation of the Authority.
- B. Licenses issued by the Authority are official documents proving the legitimacy of licenses for drilling and construction of water facilities, and any instance of writing off, modifying, or adding to their contents will result in their cancellation. In the event of loss of these licenses, the Authority will not issue replacement licenses except on the basis of official reports approved by the police stations, and certified by the competent courts.
- C The beneficiary shall bear the cost of reprocessing a license application in the following cases:
1. When the beneficiary neglects his application to the Authority for a period exceeding two months for the period specified for issuing licenses.
 2. If the beneficiary requests to change the data and information that were established in his request, and the Authority has started the procedures for registering and processing the request.
- D The beneficiary shall bear the cost of reissuing a license if:
1. A request is made to change the quantities of water or the purposes of its use, and that request is accepted by the Authority.
 2. A request is made to introduce a specific change to the design of drilling wells or water installations after issuance of the license, and it is accepted by the Authority.
 3. A request is made to replace or reissue a license due to the deletion or alteration of its contents, whether intentionally or unintentionally.
- Fourth:** The following shall be taken into account with the provisions of the licensing system:
1. The Authority shall prepare general specifications and standards for drilling wells and constructing water facilities, in coordination with the relevant authorities, so that they represent the minimum that the beneficiary is bound by.
 2. During the design or review of drilling wells and constructing water facilities, the Authority shall

provide all its expertise and all the information it has about the water conditions in basins and water areas, without assuming any responsibility therefor, and the beneficiary may seek any other expertise or technical advice, provided that his obligations regarding the specifications, conditions, controls and standards of the licensed work, as well as the methods and purposes of using water, remain in place.

Fifth: The licenses granted in accordance with the law and the provisions of this regulation shall be revoked with the force of law in the following cases:

1. If the licensee does not start excavation or construction work within a period of six months and a year, respectively.
2. If the licensee uses the license for a purpose other than that for which it was given, if the conditions stipulated in the license are not met, or if he waives the license, for or without consideration, without the approval of the Authority.

Sixth: Controls and conditions for assignment of licenses for the drilling and construction of water facilities, or sale or assignment of water rights issued by the Authority:

- A Without exceeding the conditions, specifications and quantities stated in the license or the obligations arising therefrom, the original beneficiary may assign to others the license that he obtained from the Authority to drill a well or establish a water facility, without the approval of the Authority, in the following cases:
1. When the waiver is due to urgent necessity, to meet an urgent need to use water for drinking and household uses in a manner that cannot wait for the procedures required for obtaining the approval of the Authority, provided that the provisions of the paragraphs set forth in paragraph Sixth, below, are taken into account.
 2. When the waiver concerns purposes the national security of the Republic.
 3. In the event that the ownership of the site in which the excavation was licensed or the

establishment of the water facility was transferred to the rightful heir, or the property rights devolved to others as a result of division of the property between heirs or partners.

4. In the event of selling or ceding agricultural land, real estate, industrial or touristic facilities, and other facilities and purposes that benefit from the water provided by the well or the licensed facility.
 - B The Authority shall verify the validity of the assignment, and if it does not comply with the provisions set forth in paragraph A, above, the Authority may cancel the license before the start of well drilling or the establishment of the water facility, or cancel the right to use water from the site specified in the license after completion of the licensed works.
 - C The beneficiary may not sell or relinquish a license to drill a well or construct a water facility or the rights to use water, unless he has paid all fees and costs owed by him to the Authority and other bodies.
 - D The beneficiary may, in cases of necessity, transfer all or some of the rights to use the water for drinking purposes and domestic uses, provided that the following conditions are adhered to:
 1. The water is fit for drinking and human use, and this action does not result in harm to the original or associated rights of others.
 2. The Authority has been notified and the usufruct object has been re-registered in accordance with the provisions of these regulations.
 - E A license to extract water from an alternative well shall not be granted and may not be exploited unless the first well is backfilled. The Authority shall have the right, by a decision of the Minister, to cancel the original and alternative licenses and to fill in the well without the need to issue a warning or notification, in the event that the license holder does not comply with this condition.

Article 34

Without prior licenses, manual wells may be drilled to a depth not exceeding 60 metres to obtain limited quantities of water for drinking purposes, provided that the following conditions are met:

First: Adherence to the regulations and provisions of prohibitions of water sources, installations, and water-quarantine areas, and the requirement not to harm others.

Second: Observance of customary norms and traditions related to the right to use water and the rights associated with the well and its facilities.

Third: Using drilling methods that enable the depths of wells to be measured with ordinary hand tools, or estimated with the naked eye, provided that the beneficiary takes the following actions before starting the excavation:

1. Announces his intention to drill at the specified site, in the presence of no fewer than two beneficiaries or owners near the site, and obtains a declaration from them stating that there is no objection to drilling in the specified location.
2. Notifies the Authority, its delegate, the basin committee or the local council, whichever is present in the area where the site is located, and refrains from excavating until two weeks have elapsed after such notification.
3. Commences excavation work to the permitted depth, without a license, two weeks after the above-mentioned notice, complying with any orders or instructions issued by the Authority.

Fourth: In the event that the authority, its delegate, the basin committee or the local council does not approve the excavation, it must notify the beneficiary of the justified refusal to dig within two weeks from the date of receiving the notification of the beneficiary, provided that the rejection of the request is based on the grounds set forth in paragraphs First and Second, above.

Fifth: The authority, the basin committee, or the local council may order a halt to drilling or deprive the beneficiary of benefiting from water from the well after it has been drilled, if it appears that the beneficiary has exceeded the permitted depth without a license. The penalties and sanctions stipulated in the articles of the law will apply.

Sixth: In the absence of any objections to drilling, and after completing the above procedures, the beneficiary shall register the usufruct right with the Authority in accordance with the provisions of this regulation, and shall provide all documents evidencing the usufruct right.

Seventh: The Authority may delegate specialised representatives where it is not present, provided that it defines their tasks and the limits of their powers, with written notification to the local council in the delegation area of the name, tasks and duration of work of the delegates.

Eighth: In accordance with the provisions of this regulation, the Authority shall prepare a detailed supplementary system on the conditions and controls for drilling, replacing or deepening wells and establishing water facilities in drained basins, or those subject to quarantine and protection decisions, provided that a decision is issued by the Minister, based on the presentation of the Chairman of the Authority, so that:

1. It includes urgent priorities for water uses that may not be exceeded.
2. It stipulates additional requirements for protection against pollution and depletion, including wastewater treatment, recycling or reuse of water, controls on expansion of irrigated land, installation of metres on wells, and other controls.
3. The obligations of the beneficiaries shall be separately determined according to each purpose of using each quantity of water, whether for agriculture, drinking and domestic, industrial, commercial and touristic uses.

Article 35

It is not permissible for any contractor to drill a new well or an alternative well or to construct any other water installations, unless the beneficiary presents a valid license to dig or build the facility; and the contractor must ensure that the work contract between himself and the beneficiary is consistent with that license. The contractor must present it to the bodies specified in the law upon request.

- A The technical conditions and specifications included in a license to drill a new or alternative well, deepen an existing well, or establish a water facility, shall be binding on both the beneficiary and the contractor entrusted with implementation, in particular the following:

First: Drilling and deepening wells.

1. The contractor may not engage in excavation works except in accordance with a written work contract between him and the beneficiary. The contractor must review the drilling license issued by the Authority, and must refuse to carry out any unlicensed work or work that violates the drilling conditions contained in the license.
2. The contractor shall bear the responsibility of drilling in any location other than the site specified in the license, or exceeding the authorised depth of the well, or other specifications or conditions, if he does so without the consent of the beneficiary. Both the contractor and the beneficiary shall bear the responsibility if the contractor does so based on the beneficiary's directions contrary to what it is indicated in the license.
3. In cases where an error is found in the drilling specifications, or the water bid is weak for the water-bearing layers so that they do not meet the quantities specified in the license, the beneficiary must revert to the Authority to consider the possibility of adjusting the drilling depths or other specifications, taking into account the following:
 - a In the event of an error, the Authority may allow an increase in the depth of a well or modify the specifications, provided that the depth of the well with the added depth does not exceed the depth of wells already in the same water-bearing layer.
 - b In the event of the discovery of a weakness in the water bid for a well, where further drilling is not possible for a justifiable reason from a technical or legal point of view, the Authority shall reject the request for further deepening.
 - c When drilling licenses concern remote basins and water areas that are not subject to decisions related to water-protected zones, the depth of the well may be increased by no more than five metres without referring to the Authority, provided that the Authority is notified in writing and the contractor bears responsibility for any further drilling undertaken without the approval of the Authority.
 - d The beneficiary shall bear the responsibility for any misleading or incorrect information, and failure to comply with the Authority's decision in any of the provisions of the above paragraphs shall constitute a violation for which the penalties or compensation contained in the law shall be applied.
4. The contractor, by virtue of his professional specialisation, shall bear full responsibility for the actions specified in the license for the following results and actions:
 - a Exceeding the drilling depths specified in the license or the depths permitted to be added in accordance with the provisions of the above paragraphs.
 - b Using drilling materials not authorised for use in the Republic.
 - c Failing to close unwanted first-hand layers during drilling.
 - d Ignoring technical instructions and orders received from the responsible technical supervisor, whether the supervisor is authorised by the Authority or by the competent authority.
 - e Failing to clean the well until the water is at least 90 per cent pure.
5. The beneficiary is responsible for carrying out experimental pumping of the well, measuring its flow for a period of 24-72 hours, and notifying the Authority in writing of the results of the experiment.
6. Without contravening the provision of licenses for drilling wells under this regulation, the drilling of a well shall be considered successful if the contractor obtains a certificate of completion from the engineer or technician authorised to supervise the drilling of the well, provided that the contractor is not discharged until the beneficiary has ascertained that the depths and diameters of drilling, well packaging and other aspects, and any other work, has been carried out in accordance with the technical specifications and terms of the work contract and conditions, including work related to the protection of groundwater from pollution after the completion of drilling, whether within the well or outside it.

Second: Other water installations.

1. All water installations are subject to licensing, including channels, dams, stone and earth barriers, whether above or below the surface of the earth, and including sequestration of torrential waters, floods, gorges, and natural streams, and diversion from their original or natural courses, with the exception of:

- a Collecting groundwater from wells in channels or impounding it in fixed locations, provided that it comes from previously licensed wells.
- b Establishing water installations that impound or divert a quantity of water not exceeding 500 cubic metres per year.
- c Establishing water facilities included in government plans or projects that have been fully licensed.
- d Constructing irrigation channels branching from a main irrigation network managed by official bodies, as well as secondary irrigation channels within the framework of previously licensed agricultural land.

2. Prior to issuing the license, the Authority may:

- a Review the design principles of water facilities submitted to it by the competent governmental authorities.
- b Verify the data and information stated in the request for beneficiaries who are not government agencies.
- c Participate in locating the facilities to be established with the competent authorities.
- d Determine the quantities of water that can be stored, transferred and extracted, whether from the natural water sources on which the water installations are based, or from the installations themselves.

3. The Authority undertakes to accept and register applications, issue or refuse to issue licenses, and ascertain the obligations of the beneficiary in accordance with the provisions of Article 34, above; in particular, the following must be taken into account:

- a Existing usufruct rights and associated rights above and below the water facility.
- b The reserve capacity of the water facility must withstand hydrodynamic pressure of not less than 25 per cent of the highest estimated rate, calculated according to realistic data.
- c The contractor may not start work except pursuant to written contract between the contractor and the employer, and the employer must abide by the technical conditions specified in the license and include them in the work contract.
- d Official receipt of the site from the Authority or the authority authorised by it. Neither the contractor nor the business owner may change the location of the facility without the written approval of the Authority, nor may they increase absorptive capacity without the coordination and approval of the Authority.
- e The contractor or the business owner may not dispose of construction waste or any other materials in torrent streams or locations that could harm the interests of others or the environment.

Third: Dealing with violations.

1. Without prejudice to any other, more severe, sanctions or penalties, the Authority may take any of the following actions in respect of violations with respect to the data, specifications and conditions set forth in the licenses, after warning the violator to correct the situation and in proportion with the size of the violation:

- a Suspend work until the violation is removed.
- b Cancel a license to drill or deepen a well or establish a water facility.
- c Suspend the right to use water from the well or violating facility until legal procedures have been completed.
- d Fill in the well or remove the violating facility, without compensation. The violator shall bear the costs of removing the violations committed in contravention of the specifications and conditions of the license

and the obligations submitted to the Authority, in addition to any other sanctions, penalties or compensation stipulated by the water law and other applicable laws.

Article 36

In accordance with the provisions of the law, especially articles 20, 21, 24 and 37 thereof:

- A No beneficiary may exceed the quantities, purposes of use, or other technical specifications determined by the Authority, and all must comply with the conditions specified in the license.
- B The Authority shall determine the quantities of water that may be used from measurable ground and surface water sources, whether in licenses for drilling wells, licenses for establishing water facilities, or water use rights registration certificates, in accordance with the following criteria and bases:
 1. Water quotas shall be determined on a total sectoral basis in line with the priorities of water use, according to the quantitative and qualitative indicators set out in the water plans.
 2. In the absence of a water plan, the following shall apply:
 - a Water quotas for legal persons in the State shall be determined on a discretionary basis, based on requests from the sectors using water, in coordination with and consultation between them and the authority.
 - b The quantities of water that may be used by legal persons from outside the sectors of the State, as well as by natural persons, including individuals, shall be determined on an estimated or realistic basis, according to the data and information available to the Authority.
 3. Beneficiaries shall not exceed the quantities of water or the purposes of use authorised or permitted to be extracted by any legal or natural person without the approval of the Authority.
 4. The Authority – in accordance with the priorities and as necessary – shall prepare and issue licenses for installing pumps on wells licensed to drill or on wells existing prior to the issuance of the law, and any other wells. The authority shall determine

the controls for beneficiaries' adherence to these licenses according to the importance and seriousness of water conditions in the following areas and cases:

- a Ponds and areas under water-protected zones regulations.
 - b Ponds, areas and water fields identified and allocated for drinking and domestic uses.
 - c When necessary to protect basins and water areas in which the water balance becomes negative.
 - d Water from wells not connected to the public water network, or whose water consumption cannot be estimated by other means.
5. The Authority may take practical steps that enable it to measure the quantities of water withdrawn from wells or other installations, whether to ensure compliance with the quantities licensed for extraction or to determine the quantities of water that may be used from ground and surface water, through:
 - a Supervising the experimental pumping operations carried out by the beneficiary on the wells licensed to drill.
 - b Carrying out pumping experiments using pumps installed on any existing wells selected by the Authority.
 - c Conducting measurements of falling water levels in working and non-working wells to identify the hydrodynamic parameters of the water-bearing layers and estimate indicators for safe pumping compared to the current or estimated withdrawal amounts of groundwater.
 - d Installing or notifying the beneficiaries to install metres on the wells to measure the quantities of water flow, and to confirm the extent to which the capacities of pumps installed on these wells are compatible with permissible pumping quantities, so that they may be read and monitored by the Authority or by the authorities or individuals it has authorised to do so.
 - e Measuring the quantities of water stored in or from surface water installations, and the

extent to which this enables the Authority to obtain the information and data necessary to estimate the total shares of extractable water.

- f Requesting data and information from the beneficiaries and the relevant authorities about the quantities and purposes of water use and its physical, chemical and organic properties.

- c Material, technical and human capabilities, and all immovable and movable property, constituting the basis for practicing the profession.

- d A statement of the type and number of documents attached to the application, their source and their dates.

- e A copy of a valid tax card, to be attached when submitting the application.

Article 37

A Subject to the provisions of the Contractors and Engineering Offices Classification Regulations, contractors and engineering offices may not engage in any of the following activities prior to obtaining a license to practice such work from the Authority:

1. Water well drilling.
2. Exploration for groundwater and conducting studies and advisory work in the field of water resources.
3. Distribution of water from wells directly, whether through drinking water networks or by filling containers or bottles on the part of individuals or private sector companies.

B All natural and legal persons who practice any of the businesses enumerated in this article must, within one year from the date of the issuance of the law, register themselves, their offices or companies, and the machinery and equipment they use in these professions, and obtain licenses to practice the profession from the Authority.

First: Procedures for submitting a registration and applying for a license.

1. The Authority shall prepare a separate official standard application form for each party practising the profession of drilling wells, engineering consultancy, distributing and filling water, indicating:
 - a Occupation owner’s name and nationality: contractor, company or office, partners, and type of company (public, private, mixed, joint stock, limited, etc.).
 - b Type of profession, location, branches and addresses in the Republic.

2. The beneficiary shall fill out, sign and submit an application to practice the profession on the standard forms, to be submitted to the Authority or one of its branches, and the Authority may not delegate any other party to receive it.

3. Documents submitted to the Authority: In the event that it is unable to obtain the original documents, the Authority may accept authentic documents certified by the competent authority, which bears the responsibility arising from such certification.

4. The Authority shall not deal with a representative of the beneficiary unless the representative presents an official authorisation signed and stamped by the original owner.

5. The beneficiary shall submit an acknowledgment that the information contained in the application form is correct, and the Authority shall have the right to carry out a field inspection at any time to ensure its correctness.

- a The beneficiary shall submit a commitment to abide by the terms and conditions of practicing the profession.

- b The beneficiary shall submit the approved bank guarantee valid for one year, and shall not claim it until its purpose has expired; the Authority has the right to dispose of the guarantee or any part of it for the payment of fines for violating the provisions of practicing the profession.

- c Laboratories and companies treating, filling and distributing water shall undertake to conduct monthly water quality tests, in addition to emergency or other tests, at the request of the Authority or competent authorities.

- d The quality and validity of the water that the plant or company treats, bottles or distributes, and quality of the work carried out, shall be tested periodically.
- 6 If the company or office represents a company abroad, it must indicate whether it is independent or participates or cooperates with a local entity, specifying its identity, name, and the nature of its presence in the Republic, whether temporary or permanent.

Second: The Authority shall prepare a license to practice the profession on official standard forms bearing the name and emblem of the Republic, the name of the Ministry and that of the Authority.

1. The Authority shall not issue licenses to practice the profession until completion of:
 - a Ensuring the validity and integrity of the beneficiary's request, and the information and data it contains, whether in the office or in the field, in accordance with the provisions of this regulation and any decisions or regulations emanating therefrom.
 - b Fulfilling all bank guarantees, fees and service costs owed to the Authority. The beneficiary must make payments to other parties in accordance with the provisions of the law, these regulations and any decisions or regulations emanating from them.
2. The value of the bank guarantee and the fees payable for a license to practice the profession shall be determined as follows:
 - a Well-drilling contractors and companies: the value of the guarantee and fees shall be determined according to the number, type and capabilities of drilling rigs (rotary or hammer) owned by the contractor or company.
 - b Companies and consulting offices: the value of the guarantee and fees shall be determined according to the size and extent of the work and the type of profession (experience-providing consultations, field studies, facility designs, theoretical or laboratory research, etc.).
 - c Water distribution and filling companies or contractors: the value of the guarantee and fees shall be determined according to the size and type of work (water quantity, treatment and filling, distribution through tanks, distribution through networks).
3. The size and colour of the license to practice the profession of drilling wells shall be different from the size and colour of the license to practice the profession of engineering consultancy, and the colour of the license to practice the profession of water distribution and bottling shall be different from the other two.
4. The license shall be valid for one year from the date of issuance, and the bank guarantee shall be valid for one month after the license validity date.
5. Temporary registration certificates with a validity period of not less than three months and not more than a year shall be granted to foreign firms with temporary assignments in Yemen, and the beneficiary may request their renewal for similar periods by providing justifications for their continuation.
6. The Authority shall keep a copy of the license with the application and all documents and certificates attached to the application, provided that the procedures for maintaining and documenting them follow the provisions covering the preservation of documents for drilling wells and water installations, as indicated elsewhere in this regulation.

Third: Professional licenses shall be renewed for consecutive and equal periods, each one year in duration, without the need for new documents.

The contractor, engineering office, or company must renew or reissue the license in the following cases:

1. Upon expiry of the license validity period, or when the original license is lost or damaged, the report submitted to the police and the advertisement published in one of the well-known newspapers must be submitted.
2. When the original property ownership changes through purchase, sale or partnership.
3. When the license rating category is changed.
4. When requesting renewal, the beneficiary must submit a new bank guarantee if the previous guarantee is not valid.

Fourth: Without prejudice to any other legal penalties, the Authority shall have the right to refuse to accept an application for a license to practice the profession, to request its renewal, or to issue a temporary registration certificate in the following cases:

1. If the beneficiary does not fulfill and abide by all the conditions of the application or submits incomplete supporting documents.
2. If the beneficiary provides misleading and incorrect information, including information that would obtain a classification in a category he does not deserve.
3. If the beneficiary imports excavators without the approval of the Authority within the period specified in the official media, or in violation of the provisions of this regulation and other applicable laws and regulations.
4. If the beneficiary sells or transfers ownership of the contractor's business, company or office to another owner without renewing the license within six months of completion of the sale and the transfer of ownership.
5. If the beneficiary delays submitting an application for obtaining a license, renewal, or registration certificate within six months after the announcement of these regulations, or within three months after expiration of the period of the license or registration certificate.
6. If the beneficiary undertakes work in prohibited areas for any reason, or carries out drilling or construction work, or studies or tests unlicensed wells or water facilities.
7. If the beneficiary has a history that violates the honor of the profession, and judicial rulings have been issued against him preventing him from practicing the profession.

Fifth: Without prejudice to any other penalties, the Authority has the right to cancel the license to practice the profession, reduce the category in which the beneficiary was classified, or to modify the Authority's records in proportion to the degree of any of the following violations or cases:

1. If the beneficiary performs work subject to the license and the owner of such work did not obtain a prior license from the Authority.

2. If the contractor or company imports excavators, machines, drilling materials, equipment, or metal casings for wells without the approval of the Authority and in violation of the provisions of article 44 of the law.
3. If the contractor or company repeatedly drills wells without work contracts, or with contracts that do not include specifications of the work licensed by the Authority.
4. If the contractor or company refuses to cooperate with the Authority's employees in supervising and controlling the work implemented.
5. If the contractor or company uses liquids or materials and leaves them inside or outside the wells or water installations, or if they are mixed with water intended for human use and would cause serious damage to water resources, public health, or the environment.

Sixth: The license to practice the profession is naturally considered void in the following cases:

1. Expiry of the business for any reason, or the transfer of its practice outside the territory of the Republic.
2. Declaration of bankruptcy.
3. Judicial rulings in force to stop or dissolve the business for which a license to practice the profession was issued.

Seventh: Beneficiaries have the right to appeal against the Authority decisions before the competent courts.



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