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Country Paper

Sultanate of Oman

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Sultanate of Oman Water Resources

8th Bi-annual Meeting of Arab IHP Committees

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Abstract/Summary

In the Sultanate the average rainfall is ranging from 50 mm in the interior to 300mm in the north Oman Mountains while the general average is about 100mm.

Groundwater is very important and the main source of most irrigation and domestic supplies. The major groundwater is in the alluvium aquifers in the Northern Oman and the Tertiary limestone in the South. Average annual recharge to these aquifers is about 1645Mm³ of which about 80% is recovered and the balance is lost as outflow to the sea or desert. Although surface flow does not generally constitute a direct source, it is the primary mechanism of aquifer recharge in most areas of the Sultanate as runoff concentrated in the wadi channels.

The annual total water demands is about 1721Mm³, of which the annual agricultural requirements is about 86%. The aflaj system is responsible for 32% of the total agriculture water demand while the remaining 54% are abstracted from wells. Although domestic and industrial water demand currently is about 12% only, this is expected to be more than double by the year 2020.

Comparison between water demand and annual recharge, indicate an imbalance between supply and demand in the order of 20%. Deficit of more than 30% were noticed in other regions. These deficits are directly attributable to over drawing of groundwater mainly for agriculture. In some areas the over abstraction of water, such as on the lower coastal plain of the Batinah, has led to progressive decline in groundwater level, while in other areas it results in a more rapid decline in water levels between recharge events. The saline front is advancing in some coastal areas and is stationary in others but in general the quality of water drawn from wells within 5 km of the coast is deteriorating. In the interior regions water quality also worsens in dry periods as water levels fall. On average the recharge dams contribute more than 50Mm³ additional annual recharge to aquifers, though the estimated annual outflow of more than 300Mm³ to the sea and desert indicate the potential for additional water harvesting.

Numbers of government entities are associated with water management issues; the responsibility for assessing, managing and monitoring water resources in Oman has been primarily assigned to the Ministry of Water Resources. Water use and distribution is the responsibility of the Ministry of Electricity and Water (drinking water) MWR is also responsible for the delineation of the protection zones around municipal water supply well fields as well as the monitoring activities within these

Introduction:

The Sultanate of Oman occupies the southeast coast of the Arabian Peninsula. There are four natural sub-regions comprising: a north eastern coastal plain, relatively wet mountains of up to 3000 meter elevation, a hyper-arid central desert, and southern coastal region experiencing a monsoon climate.

Hydrology and Hydrogeology of Oman :

Geographically, Oman benefits from a relatively high rainfall (300 mm/yr.) in the northern mountains (Al Hajar Al Gharbi) which recharges the aquifers of the fertile coastal plain and the interior, where the mean annual rainfall is only 100mm or less.

The climate of the southern region (Dhofar) is characterized by summer monsoon, known locally as "Khareef", which occurs between late June and late September. The Khareef is an annual event resulting from moist wind, which originates from Indian Ocean and Arabia Sea. The monsoon precipitation is composed of vertical component, which is rainfall, and horizontal component, which is fog. Native grass and trees intercept a significant part of the fog.

Groundwater in the Sultanate of Oman is of utmost importance and the source of most irrigation and domestic supplies. The major sources of water are the alluvium in the Northern Oman and the Tertiary limestone in the South. Large quantities of nonrenewable water are contained in aquifers underlying the Nejd in Southern Oman. Else where, some new groundwater basins were recently discovered with considerable amounts of fresh water suitable for long term sustainable regional domestic supplies as well as brackish water suitable for agricultural development.

In general the average annual recharge to aquifers in the whole of the Sultanate is currently estimated to be in the order of 1,645 Mm³ of which some 80% is recovered with the balance lost as outflow to the sea or desert. In addition to the recharge, there are also significant fresh and brackish water reserves, though the remote location and non-renewable nature of these reserves, has to date largely limited their development. The costly alternative Desalinated sea water and brackish water contributes 51 Mm³/yr. for the supply of municipal water, principally to Muscat, but also for drinking water to isolated coastal and rural communities.

Utilization of groundwater resources in most areas has traditionally evolved around aflaj which are channels excavated in the ground or on the surface for gathering ground water or natural spring water in order to be distributed for various uses; mainly for irrigation. Surface water flow in the Sultanate is occurring in most cases for a period of hours or few days after a storm. However, there are some cases where base flow is at the surface on a near perennial basis and some springs, flow continuously.

Although surface flow does not generally constitute a direct resource, it is the primary mechanism of aquifer recharge in most areas of the Sultanate as runoff is concentrated in the wadi channels.

than 10,000 m³ have also been constructed in the upper catchments of the Al Hajar Al Gharbi mountains of northern Oman for water supply to remote communities.

Water Management System :

Water Legislation :

Since water is a fundamental factor in life, Oman has long recognised the importance of establishing an authority to regulate the use of this vital resource. A Royal Decree was issued in 1975 for the formation of water resources council. This was then followed by number of Royal Decrees related to the development of water resources, which concluded – in 1989 - by the issuance of a Royal Decree for the establishment of the Ministry of Water resources and the designation of it's duties and responsibilities. One of the most important Decrees issued in this regard was in 1988, which declared water in the Sultanate is “a public national wealth to be exploited in the interest of agricultural and development plans according to government's directions”.

The above has been progressively supplemented with legislation defining the role and responsibilities of government and water users. The most significant of these legislation includes:

- Establishment of well permitting regulations in 1990 and revision in 1995, requiring the registration of all private wells and the need to obtain a permit for deepening of existing wells and construction of new or replacement wells.
- Declaration of regulations on disposal of wastewater from desalination plants.

Resource Management :

Number of government entities are associated with water management issues; the responsibility for assessing, managing and monitoring water resources in Oman has been primarily assigned to Ministry of Water Resources (MWR). Other ministries are more specifically responsible for water use and distribution; Ministry of Agriculture and Fisheries (MAF) oversees the agriculture sector, and Ministry of Electricity and Water (MEW) is responsible for providing and distributing safe drinking water. The Ministry of Regional Municipalities and Environment, and the Muscat Municipality (the largest), are responsible for collection, treatment and disposal of wastewater.

Resource Assessment and Monitoring by MWR :

The Ministry of Water Resources has carried out well inventory project (NWIP) during 1993 which list almost every borehole and well in the Sultanate, with its location, owner, engineering details and water quality.

More recently a National Aflaj Inventory has also been completed by the Ministry, which identified the falaj type, location and irrigated area. About 4000 falaj were inventoried during this project period (March 1997 – end 1998). The main objectives were to developing Aflaj database, defining exact sites of aflaj mother wells and supporting wells, collecting information about the characteristics of these wells, and

intrusion. 1998 recorded some 254 wastewater treatment units in all over the Sultanate, of which 122 units in Muscat (48%). The percentages of reused water from all treatment units in the Sultanate is about 60% the remaining treated water is disposed through soaking tanks or discharged in the sea for units near the sea.

MWR Strategic Planning :

The drafting of comprehensive strategy on scientific bases for the appropriate development and management of water resources will require extensive water resources data covering both quantity, quality and water use data. Major improvements in our knowledge base in recent years include the first National Census in 1993, a National Agricultural Census, the National Well and Aflaj Inventories, and detailed water balance assessments of most catchments. A National Water Resources Master Plan study is now in progress, which will synthesise these data in the context of the development plans of other ministries and the Vision 2020 strategy statement. This Plan will provide the basis for integrated water resources management for the next 20 years.

The available data will enable the Ministry to identify the major water resources aspects through the national master plan. This may include the identification of the following: -

- Type and manner of water uses (for agricultural, domestic, commercial, Industrial, or other uses)
- Water surplus and water deficit areas.
- General trends of water demand and groundwater levels.
- Type of water problems at various regions.
- Suitable water balance reflecting the actual water situation in each area.
- Outline the basic technical development options and suggest remedial measures to overcome the restrictions that may hinder the execution of these options.

The Master Plan will include the delineation of an appropriate technical, legal, and institutional framework to ensure the most appropriate use of water resources. The plan will be consistent with the social and economic situation of the country and will secure sustainable main water supplies until the year 2020.

estimating the demands of aflaj water. This information, in addition to National Well Inventory (NWI) data will contribute in deciding the national water balance strategy. Networks of rain gauges, wadi gauges and monitoring boreholes have been extended and databases established.

Resource Protection and Conservation :

Pollution control is the responsibility of Ministry of Regional Municipalities and Environment. However, MWR is specifically responsible for specifying protection zones around municipal well fields and for monitoring activities within these zones that threaten water quality.

The main objective of protecting water resources, especially fresh groundwater, is to ensure sustainable supplies to meet the current and future drinking water demands both quantitatively and qualitatively. Groundwater protection includes prevention of pollution, and salinity intrusion, and over abstraction of groundwater aquifers. As most of the aquifers are unconfined and vulnerable to pollution, it is not easy to prevent soil pollution and hence groundwater aquifer.

The major action taken by the ministry for the protection of water resources in the Sultanate is the establishment of wellfield protection zones for the municipal wells in the major cities within wellfield and aquifer protection programme. Any development activities within these catchments should be according to the rules of the wellfield protection zone. These rules have direct effect on restricting groundwater pollution.

Conservation is promoted through public awareness among user groups, with frequent campaigns on television and radio, in schools and women' groups. Conservation projects have included feasibility studies to promote water saving in residential/commercial buildings and demand management projects in the agriculture sector.

Nontraditional Water Supplies :

There are 54 desalination plants in the Sultanate; most are located in remote and coastal areas where shortage of water is experienced. However, these represent about 10% only of total production of the 54 plants. The major production is in Muscat Government (about 90%).

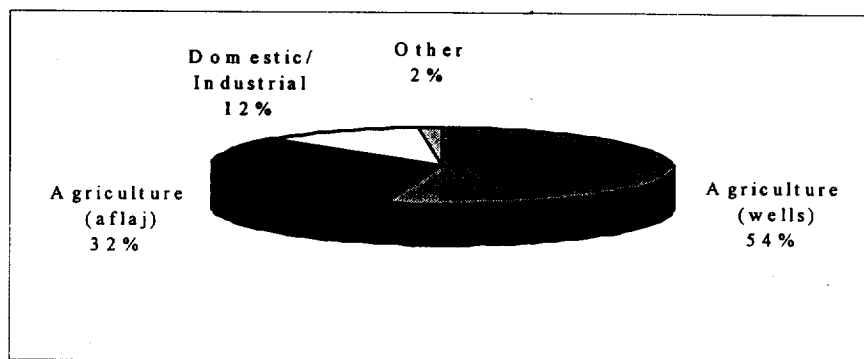
Wastewater treatment units exist in various areas in the Sultanate. Muscat Municipality and the Ministry of Regional Municipalities and Environment is responsible for the designation and installation of treatment units

Currently about 23 Mm³/yr. of treated wastewater is used for horticulture and municipal beautification in Muscat and associated suburbs. A scheme currently proposed will ultimately increase the total volume of treated water to 90 Mm³/yr. by year 2010. While some of this water (16 Mm³/yr.) will be used for additional landscape irrigation, the balance could be available for other uses such as aquifer recharge and agricultural irrigation. In Salalah in southern Oman a major wastewater-recycling project is currently being implemented; the scheme includes the collection and treatment of wastewater for recharge to the coastal aquifer to prevent saline

Water Demand :

The annual total water demands in the Sultanate is about 1721 Mm³. Where the annual requirement of the agricultural sector is 1487 Mm³ (86%), which irrigate 72000 hectares in all over the Sultanate. The aflaj system is providing 32% of the above while 54% is obtained from wells.

The percentage of domestic and industrial use is about 12%. Domestic water demand is expected to be more than double by the year 2020, due to population growth and increased per capita consumption. Industrial water consumption is also expected to increase significantly in response to policies encouraging diversification of the economy away from dependency on oil revenues. Figure 1 below shows water use by sector.



Water Quality :

Al Batinah is the most suffering area where the annual deficit is about 245 Mm³. This has resulted in sea water intrusion and salinity increase in groundwater and agricultural lands. The deficit in the Interior has resulted in the dryness of several wells and aflaj, as is the water supply shortage in some other wilayat (regions) has contributed to the dryness of its wells and aflaj too.

The quality of water available for agriculture varies. On the coastal plains where groundwater overdraft has been most severe, saline intrusion has occurred. In near-shore parts of the Batinah coast the water quality is now too poor even to grow salt tolerant crops such as dates and grass. The saline front is advancing in some coastal areas and is stationary in others but in general the quality of water drawn from wells within 5 km of the coast is deteriorating. In the interior regions water quality also worsens in dry periods as water levels fall and pumps draw older water from deeper in the aquifers.

Groundwater Recharge:

Since 1985 groundwater augmentation by artificial recharge of floodwaters has been a major component of water policy, with the construction of 17 recharge dams with a combined reservoir capacity of 57 Mm³. On average the dams contribute more than 50 Mm³ additional recharge to aquifers per year, though the estimated outflow of more than 300 Mm³/yr. to the sea and desert indicate the potential for additional water harvesting. Thirty small retention or storage dams, with reservoir capacities of less

zones that threaten water quality. This is progressively supported by various legislation that define the role and responsibilities of government and water users.

A National Well Inventory has been compiled by MWR, which lists every borehole and well in the country. More recently MWR has also completed National Aflaj Inventory. The two projects identified wells and aflaj types, locations, owners, and water quantity and quality.

The main nontraditional water resources in the Sultanate are desalinated water and treated wastewater. There are 54 desalination plants in all over the Sultanate. The major desalination plants production is in Muscat Governorate (90 %). About 23 Mm³ /yr. of treated wastewater is used for horticulture and municipal beautification in Muscat and other towns.

A National Water Resources Master Plan is now under preparation by MWR. It will synthesize the available data in the context of national development plans. This plan will include the delineation of an appropriate technical, legal, and institutional framework to ensure the most appropriate water resources development. The plan is setting certain policies for the exploitation of new water resources which will be in accordance with the government priorities after concentration on drafting a suitable sustainable development water resources strategy that can cover water requirements for the various sectors until year 2020.