Development of Water Information System for the Kingdom of Bahrain (BWRDB)

The 14th Gulf Water Conference

"Water in the GCC … Towards Economic Efficiency and Financial Sustainability"

13 – 15 February 2022, Riyadh – Kingdom of Saudi Arabia

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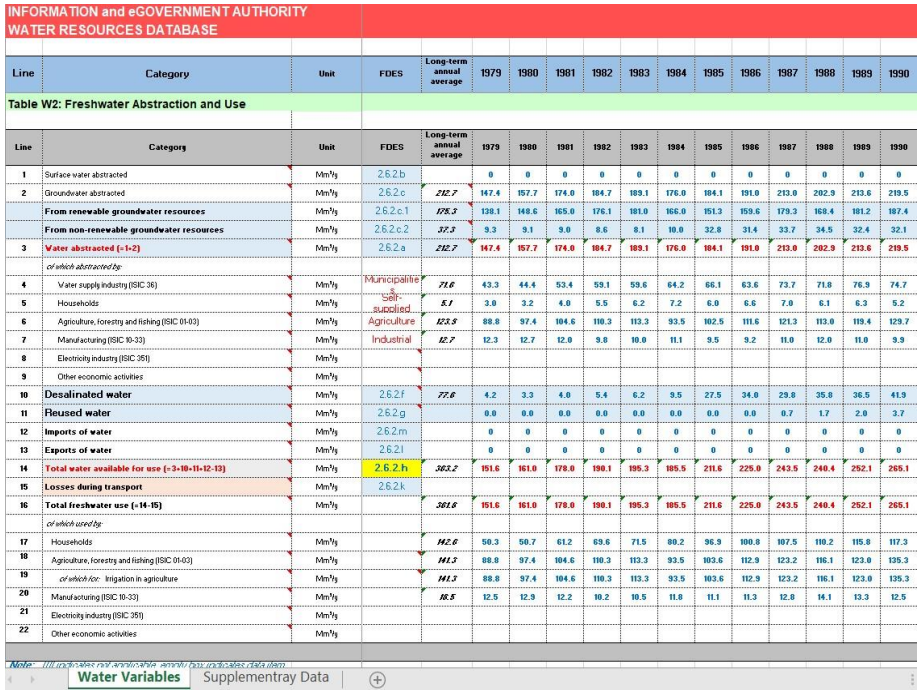
Overview

- What is the BWRDB?
- Why the BWRDB?
- Methodology
- The Scope and Structure of the BWRDB
- Examples for Database Components and Structures
- BWRDB Sample Data
- Next Steps

What is the BWRDB?

A robust, simple, flexible and timely metadata-driven MS Office Excel Spreadsheets data storage and management system.



INFORMATION and eGOVERNMENT AUTHORITY
WATER RESOURCES DATABASE

Table W2: Freshwater Abstraction and Use

Line	Category	Unit	FDES	Long-term annual average	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	Surface water abstracted	Mm^3/y	2.6.2.b		0	0	0	0	0	0	0	0	0	0	0	0
2	Groundwater abstracted	Mm^3/y	2.6.2.c	*212.7*	147.4	157.7	174.0	184.7	189.1	176.0	184.1	191.0	213.0	202.9	213.6	219.5
	From renewable groundwater resources	Mm^3/y	2.6.2.c.1	*178.3*	138.1	148.6	165.0	176.1	181.0	166.0	151.3	159.6	179.3	169.4	181.2	187.4
	From non-renewable groundwater resources	Mm^3/y	2.6.2.c.2	*37.3*	9.3	9.1	9.0	8.6	8.1	10.0	32.8	31.4	33.7	34.5	32.4	32.1
3	**Water abstracted (=1+2)**	Mm^3/y	2.6.2.a	*212.7*	147.4	157.7	174.0	184.7	189.1	176.0	184.1	191.0	213.0	202.9	213.6	219.5
	of which abstracted by:															
4	Water supply industry (ISIC 36)	Mm^3/y	Municipalities	*71.6*	43.3	44.4	53.4	59.1	59.6	64.2	66.1	63.6	73.7	71.8	76.9	74.7
5	Households	Mm^3/y	Self-supplied	*5.1*	3.0	3.2	4.0	5.5	6.2	7.2	6.0	6.6	7.0	6.1	6.3	5.2
6	Agriculture, forestry and fishing (ISIC 01-03)	Mm^3/y	Agriculture	*123.8*	88.8	97.4	104.6	110.3	113.3	93.5	102.5	111.6	121.3	113.0	119.4	129.7
7	Manufacturing (ISIC 10-33)	Mm^3/y	Industrial	*12.7*	12.3	12.7	12.0	9.8	10.0	11.1	9.5	9.2	11.0	12.0	11.0	9.9
8	Electricity industry (ISIC 351)	Mm^3/y														
9	Other economic activities	Mm^3/y														
10	**Desalinated water**	Mm^3/y	2.6.2.f	*77.6*	4.2	3.3	4.0	5.4	6.2	9.5	27.5	34.0	29.8	35.8	36.5	41.9
11	**Reused water**	Mm^3/y	2.6.2.g		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.7	2.0	3.7
12	**Imports of water**	Mm^3/y	2.6.2.m		0	0	0	0	0	0	0	0	0	0	0	0
13	**Exports of water**	Mm^3/y	2.6.2.l		0	0	0	0	0	0	0	0	0	0	0	0
14	**Total water available for use (=3+10+11+12-13)**	Mm^3/y	2.6.2.h	*363.2*	151.6	161.0	178.0	190.1	195.3	185.5	211.6	225.0	243.5	240.4	252.1	265.1
15	**Losses during transport**	Mm^3/y	2.6.2.k													
16	**Total freshwater use (=14-15)**	Mm^3/y		*361.6*	151.6	161.0	178.0	190.1	195.3	185.5	211.6	225.0	243.5	240.4	252.1	265.1
	of which used by:															
17	Households	Mm^3/y		*142.8*	50.3	50.7	61.2	69.6	71.5	80.2	96.9	100.8	107.5	110.2	115.8	117.3
18	Agriculture, forestry and fishing (ISIC 01-03)	Mm^3/y		*141.3*	88.8	97.4	104.6	110.3	113.3	93.5	103.6	112.9	123.2	116.1	123.0	135.3
19	*of which for:* Irrigation in agriculture	Mm^3/y		*141.3*	88.8	97.4	104.6	110.3	113.3	93.5	103.6	112.9	123.2	116.1	123.0	135.3
20	Manufacturing (ISIC 10-33)	Mm^3/y		*16.5*	12.5	12.9	12.2	10.2	10.5	11.8	11.1	11.3	12.8	14.1	13.3	12.5
21	Electricity industry (ISIC 351)	Mm^3/y														
22	Other economic activities	Mm^3/y														

Note: ... (0) indicates not available, empty box indicates data item

Water Variables | Supplementray Data

Current version:

- A complete set of harmonised and internationally comparable data on water resources and their uses.

- Contextual datasets on and generated information on demographic, economic, environmental and climatological information related water resources assessment and management.

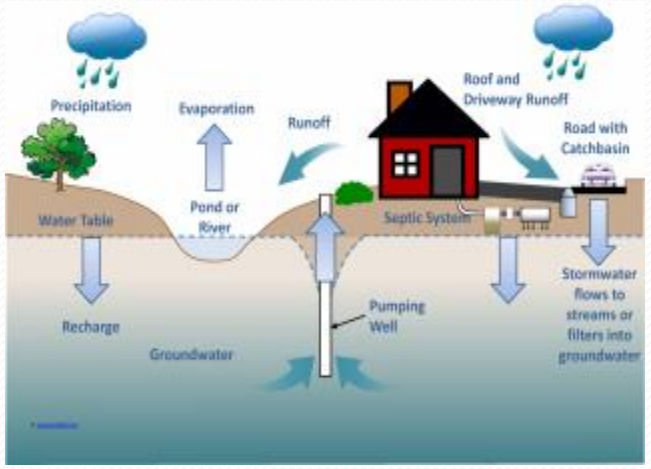
Upcoming version:

- To integrate and interface the existing datasets with GIS-based visualisation tools and web-portal facilities.

Why the BWRDB?

The prime objectives of the BWRDB are:

- to provide a reliable, timely, up-to-date, standardized and internationally comparable water data and relevant information for knowledge sharing and dissemination;
- to support effective evidence-based decision and policy-making processes in water planning and sustainable water management;



Cont., Why the BWRDB?

- to provide water data and water-related information for tracking and reporting on progress against the SDG 6 targets and global indicators; *and*
- to cater for and support the specific requirements of the Gulf Cooperation Countries Unified Water Strategy and Implementation Plan.

Methodology

Draws on the wide international experiences from the development of water data storage management and information systems (e.g. IRWS, UNSD/UNEP QW, Eurostat/OECD JQ-IW, FAO/AQUASTAT, FDES, UNECE, SEEAW, ISIC).

Defined in three phases:

1. Methodology Phase1 (Initial Stage): Assessing data and information needs

    - data identification and prioritization;
    - data availability and accessibility;
    - data providers and production procedures; and
    - assessment of national monitoring systems.

Summary of the data and information needs assessment

Cont., Methodology

Data sources	Data topics and variables	Data providers
Hydrological monitoring data: These are mainly in situ monitoring data obtained from groundwater monitoring networks.	• In situ observation of historical data on groundwater levels and quality. • Measured historical data on groundwater abstraction and sectoral groundwater use. • Data on the number of water meters installed.	• Ministry of Works, Municipalities Affairs, and Urban Planning (MoWMAUP) - Agriculture Engineering and Water Resources Directorate (AEWRD)
Administrative data: These types of data are broad in nature and are usually kept by the concerned authorities for administrative, water resources assessment and management purposes, long-term planning and data sharing and dissemination, including geospatial data, and off-line data on rules and regulation enforcement, water license conditions, etc.	• Hydrological data on boreholes logs, aquifer geometry, lithology, hydraulic properties, and geophysical logging. • Data on numbers of boreholes drilled, locations and ownership. • Ex situ data on pumping tests, well yields and aquifer recharge. • Data on springs discharge, number of springs and locations. • Numbers and geospatial data on geographical locations and distribution of hydrological and monitoring data points. • Hydrologic measurements on springs flows and quality. • Topographic and contour maps on groundwater-related datasets. • Measured datasets on volume of wastewater flows and quality of wastewater produced, reused and discharged of to the environment, plants design capacities, sludge production, as well as data related to sanitation services infrastructures. • Measured datasets on quantity and quality of desalinated water produced, desalination plants design capacities and data and information on infrastructures related to drinking water services. • Number of establishments and employment in drinking water and sanitation services. • Ex situ laboratory data on chemical and microbiological quality of drinking water and reused wastewater at end users' outlets. • Off-line data and Information on water and sanitation regulations and laws, water use permits, water sales, water tariffs, etc.	• MoWMAUP - AEWRD. • MoWMAUP - Sanitary Engineering Planning and Projects Directorate (SEPPD) • MoWMAUP - Sanitary Engineering Operation & Maintenance Directorate - (SEOMD) • Electricity and Water Authority (EWA) - Water Production Directorate (WPD) • EWA - Water Transmission Directorate (WTD) • Ministry of Health (MH) - Public Health Directorate (PHD)
Environmental monitoring data: Includes data collected from in situ measuring points used for monitoring changes on ecosystems health and ambient water quality.	• Data on the state of environment and quality and health of aquatic ecosystems. • Amounts of sediments and nutrients load to receiving water. • Number and locations and distribution of the monitoring points (this may also be regarded as administrative data).	• Supreme Council for Environment (SCE) - Environmental Policies and Planning Directorate (EPPD)

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Data sources	Data topics and variables	Data providers
Census and other economic and demographic Surveys data: Census and surveys of households and establishments, … etc.	• Population censuses and population projections. • Percentage of the population connected to drinking water services. • Percentage of the population connected to sanitation services. • National accounts and other economic-related data. • Other demographic and socio-economic domains information.	• Information and eGovernment Authority (IGA) • MoWMAUP • EWA
Agricultural data and surveys: Statistical and surveys-related data on agriculture variables, including geospatial data.	• Agricultural areas, crop patterns, crop yields and production, evapotranspiration, lands ownership, manpower in agriculture. • Geospatial data on soil patterns and characteristics, agricultural land areas, arable lands and other agriculture statistics. • Surveys on groundwater quality.	• MoWMAUP - AEWRD • MoWMAUP - Agriculture Statistics Department (ASD) • IGA
Meteorological monitoring data: In situ data obtained from meteorological stations.	• In situ observation and/or real-time data on various climatological parameters. • Numbers of meteorological stations and their geographical distribution (this may also be regarded as administrative data).	• Ministry of Transport and Communications (MTC) - Meteorological Directorate (MD) • Other private meteorological stations
Other environmental data: Various types of somewhat administrative and/or geospatial data and water-related information, provided by several institutions, stakeholders and private sectors.	• Land use patterns, land areas, land covers, biodiversity, etc. • Reported data on groundwater abstraction from private wells. • Data on industrial lands, industrial permits, industrial standard classification (ISIC), etc. • Bottled water imports and exports. Data on bottled water use. • Measured data on wastewater flows from private urban and industrial wastewater plants. Data on numbers of plants, establishments and employment characteristics. • Measured data on production from private desalination units. • Data on numbers of plants and employment characteristics.	• IGA • Survey and Land Registration Bureau (SLRB) - Topographic Survey Directorate (TSD) • Ministry of Industry, Commerce, and Tourism (MoICT) • Other Stakeholders and private sectors who have their own wastewater treatment and/or desalination facilities
Research data: These are mainly supplementary or gaps fillings primarily of derived nature water data and related information provided by various academic institutions, research centers, consultancy studies, international and regional agencies.	• Supplementary hydrological, hydrometric and meteorological data from various consultancy and academic assessment studies and surveys. • Forecast products, outputs from predictive models, and inference data from remote sensing and other emerging technologies. • Specialised reports and databases of the regional and international organisations.	• Academic institutions • Research centers • Specialised consultant firms • International and regional organisations

2. Methodology Phase II (First Implementation Stage): Data collection and quality control

   - Designing and implementing a comprehensive data collection and compilation programme;
   - Highlighting data gaps and limitations;
   - Data standardization;
   - Data verification and validation for quality assurance; and
   - Generation of water-related information and indicators.

3. Methodology Phase III (Second Implementation Stage): Integrating and interfacing the BWRDB with a GIS-based platform and web-portal services.

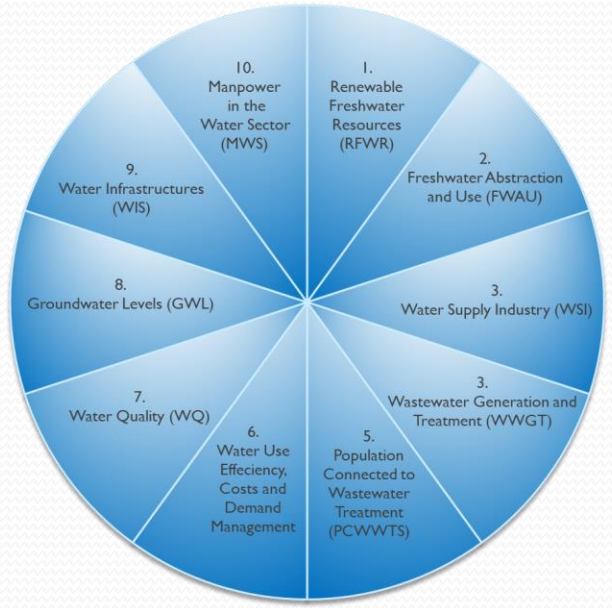
Setting variables code

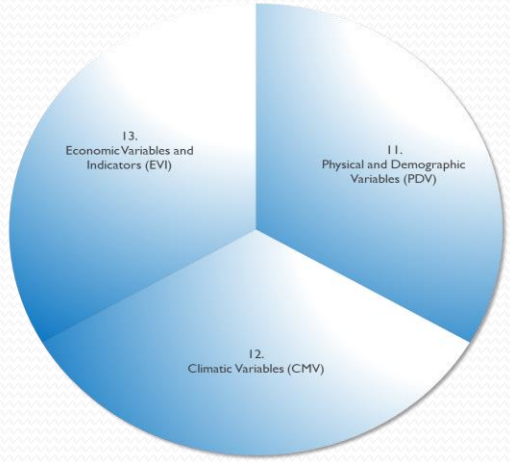
- A two-digit variables coding system has been developed.
- Combines the initial of the respective variable with its line and component number.
- A slightly distinctive coding was assigned to the variables signifying the long-term annual averages (LTAA).

Line	Variable	Variable code	Unit	LTAA	2015
5	Freshwater abstracted by households	FWAHH_02_05	Mm^3/year		2.1
3	Net water supplied by water supply industry	NWSI_03_03	Mm^3/year		260.5
7	Wastewater treated in urban wastewater plants	WWTU_04_07	1000 m^3/day		399.3
4	Total dissolved solids	TDS_7.3_04	mg/l		246.0
12	Rainfall	CMVRAIN_12_01	mm		65.0
00	LTAA Fresh groundwater abstraction	FGWA_LTAA_00			

The Scope and Structure of the BWRDB

- The scope of BWRDB covers a wide range of water statistics, relevant information and generated indicators.
- Organised into two Master Tables comprising 13 Main Tables (Components), 31 Sub-components and more than 440 statistical topics or variables.
- Master Table I: Water Variables (BWRDB_WVAR) contains 10 components.
- Master Table II: Supplementary Variables (BWRDB_SVAR) contains three components.





Cont., The scope and structure of the BWRDB

Water Variables (BWRDB_WVAR)			
Item	**Code**	**Component**	**Definition**
Component 1.0	**RFWR**	Renewable Freshwater Resources	This component assesses the renewable freshwater resources (surface and groundwater) and their availability in a country. Renewable freshwater resources are replenished by precipitation (less evapotranspiration) falling over the territory of the country that ends up as runoff to rivers and recharge to aquifers (internal flow), and by surface waters and groundwater flowing in from neighbouring countries (inflow). The component also includes the outflow of surface and groundwaters to neighbouring countries and to the sea (which is not included in the equation to determine the amount of renewable freshwater resources). The outflow to neighbouring countries is divided into that which is secured by treaties and that which is not secured by treaties (UNSD/UNEP, 2013). Inland water stocks (supposedly Sub-component 1.2) that Include surface water stocks in artificial reservoir; lakes; rivers; streams; wetlands; snow; ice; and glaciers. Groundwater stocks, water rights and licensing are part of this sub-component but has not been considered in the BWRDB because most of the data required are not applicable to the Bahrain situation. Groundwater stocks were not calculated.
Component 2.0	**FWAU**	Freshwater Abstraction and Use	Freshwater can be abstracted from surface waters (rivers, lakes etc.) and from groundwaters (through wells or springs). Water is abstracted by the public or private bodies whose main function is to provide water to the public (the water supply industry). It can also be directly abstracted by industries, farmers, households and others. The component asks for data on abstraction of freshwater, broken down according to the main activity of the water abstractor, as defined by the International Standard Industrial Classification of all economic activities (ISIC Rev. 4). The component covers the amount of water made available for use by abstraction, desalination, reuse and net imports. Total freshwater use equals total water available for use minus losses during transport. The component also covers the overall amount of water used by the main ISIC groupings.
Component 3.0	**WSI**	Water Supply Industry	This component focuses on the water supply industry, i.e., the public or private bodies whose main function is to provide water to the public. The component asks for the quantities of water supplied by the water supply industry to its customers (water users), broken down by the main ISIC groupings. It also asks for water losses and for the population served by the water supply industry. The term water supply industry is identical to “public water supply” and it refers to economic units belonging to ISIC 36 (water collection, treatment and supply). Sub-component 3.1 (PCWSI): the share (coverage) of the population connected to the drinking water supply network is also part of this component.

Cont., The scope and structure of the BWRDB

Water Variables (BWRDB_WVAR)			
Item	**Code**	**Component**	**Definition**
Component 4.0	**WWGT**	Wastewater Generation and Treatment	Wastewater can be generated from various economic activities and households. Wastewater can be discharged directly into water bodies or may be treated to remove some of the pollutants before being discharged. Component 4 asks for data on the amount of wastewater generated as well as the amount of wastewater treated in the sewerage industry, in other treatment plants, and in independent treatment facilities. The component distinguishes primary, secondary and tertiary treatment according to the level of wastewater treatment.
Component 5.0	**PCWTS**	Population Connected to Water Treatment Systems	The share of the resident population connected to public wastewater collecting system, to public wastewater treatment and to independent treatment facilities indicate the coverage and level of sanitation.
Component 6.0	**WECDM**	Water Use Efficiency, Cost, and Demand Management	Water may be used in efficient or inefficient manners. Water pricing and other demand management tools can encourage water saving and efficient water uses in the different water sectors. Component 6 presents some efficiency measures and includes important water use indicators such as per capita water use, per capita water of renewable water resources, water stress, treatment rate, … etc.
Component 7.0	**WQ**	Water Quality	Water quality may be defined as the physical, chemical, biological and organoleptic (taste-related properties of water (UN, DESIPA, 1996). Component 7 presents parameter-specific water quality data for the groundwater aquifers, blended water (desalinated and groundwater) used for households, wastewater (raw, secondary treated, and tertiary treated), and natural springs, including both the land and offshore springs.
Component 8.0	**GWL**	Groundwater Levels	Depths of to water-table or piezometric surface measured from standard datum usually mean sea level. Component 8 offers historical datasets on groundwater levels for the main aquifer units (Alat Limestone, Khobar, and Rus - Umm Er Radhuma).
Component 9.0	**WIS**	Water Infrastructure	Water is withdrawn from and produced by different sources. It also stored in and transmitted and distributed to water users via certain water infrastructures and installations. Monitoring stations usually installed to monitor and evaluate changes in the water behaviour. Component 9 gives data on the different types of water-related infrastructure, including desalination and wastewater facilities, water storage and distribution installations, irrigations and drainage networks, hydrological and climatic stations, water wells surveys … etc.
Component 10.0	**MPWS**	Manpower in the Water Sector	Employees working in the main water sectors, including engineers, technical staff, administrative staff, and ancillary workers. Data are classified based on the sub-sector of water industry. The component also presents percentages of manpower based on the nationality and job titles to meet the water management requirements for the Unified GCC - Water Strategy 2035.

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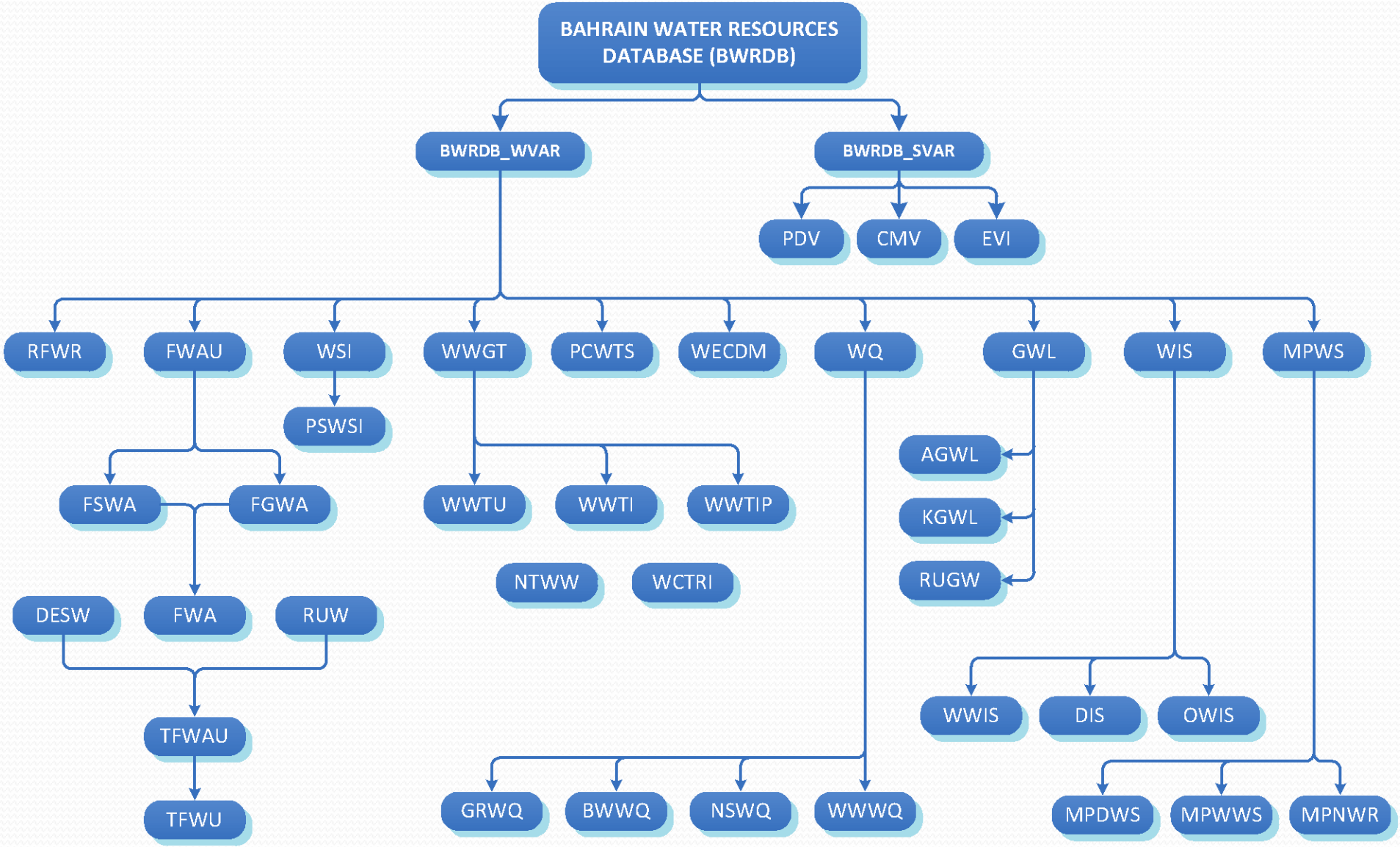
Supplementary Variables (BWRDB_SVAR)			
Item	**Code**	**Component**	**Definition**
Component 11.0	**PDV**	Physical and Demographic Variables	Contains supplementary data items essential for hydrological and water resources management studies, and for calculating of some important indicators, including land area, agricultural area, population, population growth, … etc.
Component 12.0	**CMV**	Climatic Variables	Climate may be defined as the condition of the atmosphere at a location or region over a long period of time. It is the long-term summation of atmospheric elements - such as solar radiation, temperature, humidity, precipitation, atmospheric pressure, and wind (speed and direction) - and their variations. These variables and others are provided in this component as supplementary data to the main water use and hydrogeological datasets.
Component 13.0	**EVI**	Economic Variables and Indicators	Some economic variables such as gross domestic product, average per capita income, value added for various economic activities, and other water-related economic variables are good addition to the water management studies. For example, value added datasets are used to compute water use efficiencies as required for SDG Goal 6 indicator 6.4.1.

Cont., The scope and structure of the BWRDB



Cont., The scope and structure of the BWRDB

Bahrain Water Resources Database (BWRDB)		
Initial code	**Component/Sub-component/Category**	**Remarks/data status and coverage**
BWRDB_WVAR	**Bahrain Water Resources Database - Water Variables**	**Master Table I**
Component 1.0: Renewable Freshwater Resources (RFWR)		
RFWR	Renewable freshwater resources	Sub-component 1.1.
Component 2.0: Freshwater Abstraction and Use (FWAU)		
FSWA	Fresh surface water abstracted	Sub-component 2.1. Not applicable to the Bahrain situation.
FGWA	Fresh groundwater abstracted	Sub-component 2.2. Time-series records available for years 1979 - 2017. Data are disaggregated by sector in accordance with ISIC Rev.4.
FGWR	Renewable fresh groundwater	Sub-component 2.2.1. Time-series records available for years 1979 - 2017. Data are disaggregated by sector in accordance with ISIC Rev.4.
FGWNR	Non-renewable fresh groundwater	Sub-component 2.2.2. Time-series records available for years 1979 - 2017. Data are disaggregated by sector in accordance with ISIC Rev.4
FWA	Freshwater abstracted = FSWA+ FGWA	Data available 1979 - 2017. Computed and disaggregated by abstraction for water supply industry, and by sector in accordance with ISIC Rev.4.
DESW	Desalinated water	Sub-component 2.3. Aggregated data available for years 1979 - 2017.
RUW	Reused water	Sub-component 2.4. Summed up data on treated sewage effluent). Data available for years 1982 - 2017.
IOW	Imports of water	Excludes bottled water. Not applicable to the Bahrain situation.
EOW	Exports of water	Not applicable to Bahrain.
TFWAU	Total freshwater available for use = FWA + DESW + RUW + IOW - EOW	Aggregated time series data available for years 1979 - 2017.
LDT	Losses during transport	Sub-component 2.5. Includes transmission losses only.
TFWU	Total freshwater Use = TFWAU - LDT	Time-series data available for years 1979 - 2017. Further computed and disaggregated by sector in accordance with ISIC Rev.4.
Component 3.0: Water Supply Industry (WSI)		
WSI	Water supply industry	Sub-component 3.1. Data are available for years 1979 - 2017. Further Data disaggregated by sector in accordance with ISIC Rev.4.
PSWSI	Population supplied by water supply industry	Sub-component 3.2. Total population served by WSI. Classification to urban and rural population not applicable to Bahrain.
Component 4.0: Wastewater Generation and Treatment (WWGT)		
WWG	Total wastewater generated	Sub-component 4.1. Not measured at present.
WWC	Total wastewater collected	Sub-component 4.2. Data availability for years 1982 – 2017.
WWT	Total wastewater treated	Sub-component 4.3. Total aggregated data available for years 1982 – 2017. Disaggregated by levels of treatment.
WWTU	Wastewater treated in urban plants	Sub-component 4.3.1. Time series data for years 1982 – 2017. Data disaggregated by levels of treatment.
WWTI	Wastewater treated in other (Industrial) plants	Sub-component 4.3.2. Data available for years 1985 -2017. Data disaggregated by levels of treatment.
WWTIP	Wastewater treated in independent plants	Sub-component 4.3.3. Data are available for one plant 2006 2016. Due to small volume, data included within urban plants.

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Cont., The scope and structure of the BWRDB

Bahrain Water Resources Database (BWRDB)		
Initial code	**Component/Sub-component/Category**	**Remarks/data status and coverage**
NTWW	Non-treated Wastewater	Sub-component 4.4. available only for some years.
WCTRI	Wastewater collection, treatment, and reuse indicators	Sub-component 4.5. Data computed for years 2000 - 2017, but to be finalised. Data for previous years not yet computed
Component 5.0: Population Connected to Wastewater Treatment (PCWCTS)		
PCWCS	Population connected to wastewater collection systems	Sub-component 5.1. Total population served. Classification into urban and rural does not apply to the Bahrain situation.
PCWTS	Population connected to wastewater treatment systems	Sub-component 5.2. Total population served. Classification into urban and rural does not apply to the Bahrain situation.
PNCWT	Population not connected to wastewater treatment	Sub-component 5.3.
Component 6.0: Water Use Efficiencies, Costs, and Demand Management (WECDM)		
WECDM	Water Use efficiencies, costs, and demand management	Only a few data are available. The component is yet to be finalised in terms of data and possible sub-component classifications.
Component 7.0: Water Quality (WQ)		
GRWQ	Groundwater water quality	Sub-component 7.1. Data are categorized by aquifers.
AAWQ	Alat Limestone aquifer water quality	Sub-component 7.1.1. Time-series data available for years 2005 - 2017. Also available for specific years.
KAWQ	Khobar aquifer water quality	Sub-component 7.1.2. Records are available for years 2005 - 2017. Also available for specific years.
RUWQ	Rus - Umm Er Radhuma aquifer water quality	Sub-component 7.1.3. Time-series data available for years 2005 - 2017. Also available for specific years.
RJWQ	Ras Abu-Jarjur Wellfield water quality	Sub-component 7.1.4. Time-series records are available for years 1985 - 2017.
BWWQ	Blended water quality	Sub-component 7.3. Data are available for years 2005 - 2016.
NSWQ	Natural spring water quality	Sub-component 7.4. Data classified by type of springs. Data available only for some years.
LSWQ	Land springs water quality	Sub-component 7.4.1. Data are available only for specific years.
OSWQ	Offshore springs water quality	Sub-component 7.4.2. Data are available only for specific years.
WWWQ	Wastewater water quality	Sub-component 7.5. Data are classified as raw wastewater and levels of treatment. Data are available up to the year 2017.
RWWQ	Raw wastewater quality	Sub-component 7.5.1. Data are available for years 1996 - 2017.
STWQ	Secondary treated wastewater quality	Sub-component 7.5.2. Data are available for years 1996 - 2017.
TTWQ	Tertiary treated wastewater quality	Sub-component 7.5.3. Data are available for years 1996 - 2017.
Component 8.0: Groundwater Levels (GWL)		
GWL	Groundwater levels	Data categorized by aquifers.
AGWL	Alat Limestone groundwater levels	Sub-component 8.1.1. Time-series data available for years 2005 - 2017. Also available for some specific years.
KGWL	Khobar groundwater levels	Sub-component 8.1.2. Time-series data available for years 2005 - 2017. Also available for some specific years.
RUGWL	Rus - Umm Er Radhuma groundwater levels	Sub-component 8.1.3. Time-series data available for years 2005 - 2017. Also available for some specific years.

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Cont., The scope and structure of the BWRDB

Bahrain Water Resources Database (BWRDB)		
Initial code	**Component/Sub-component/Category**	**Remarks/data status and coverage**
Component 9.0: Water Infrastructure (WIS)		
WIS	Water Infrastructure	Data classified by type of water infrastructure.
WWIS	Wastewater treatment infrastructure	Sub-component 9.1. Data are available up to the year 2017. Data computed and disaggregated by the required parameters. Many data gaps and limitations.
DIS	Desalination infrastructure	Sub-component 9.2. Data are available up to the year 2017. Data computed and disaggregated by required parameters. Some data gaps.
OWIS	Other water infrastructure	Sub-component 9.3. Data are available up to the year 2017. Data computed and disaggregated by required parameters. Many data gaps and limitations.
Component 10.0: Manpower in the Water Sectors		
MPWS	Establishments and manpower in the water sectors	Total employment and establishments in the water sector. Data classified by water sector (i.e. natural resources, desalination, treated wastewater)
MPDWS	Establishments and manpower in the desalination and water supply sector	Sub-component 10.1. Data available for years 2000, 2005, 2010, and 2015, but with some data gaps.
MPWWS	Establishments and manpower in the wastewater and sanitation sector	Sub-component 10.2. Data available for years 2000, 2005, 2010, and 2015, but with some data gaps.
MPNWR	Manpower in the natural water resources sector	Sub-component 10.3. Data available for years 2000, 2005, 2010, and 2015, but with some data gaps.
BWRDB_SVAR	**Bahrain Water Resources Database - Supplementary Variables**	**Master Table II**
Component 11.0: Physical and Demographic Variables (PDV)		
PDV	Physical and demographic variables	Not yet completed. It may be categorised into sub-components. Long time-series records available for most of the variables.
Component 12.0: Climatic Variables (CMV)		
CMV	Climatic variables	Data are available for seven climatic variables for time span for years 1979 - 2017. Evaporation data only available for years1983 - 2017. No time series data are available for evapotranspiration, only for specific years.
Component 13.0: Economic Variables and Indicators (EVI)		
EVI	Economic variables and indicators	Not yet completed, but sufficient time-series records available for most of the variables. Shall host more sub-components in the second stage of the database development.

Examples for Database Components and Structures

Component 2.0: Freshwater Abstraction and Use (FWAU)					
Line	**Variable/Category**	**Variable Code**	**Unit**	**Definition**	**Data providers/availability/gaps and challenges**
1	Fresh surface water abstraction	FSWA_02_01	Mm^3/year	Surface water is the water which flows over, or rests on, the surface of a land mass; natural watercourses such as rivers, streams, brooks, lakes, etc., as well as artificial watercourses such as irrigation, industrial and navigation canals, drainage systems and artificial reservoirs. Water obtained through bank filtration is included under (fresh) surface water. Sea-water, and transitional waters, such as brackish swamps, lagoons and estuarine areas are not considered fresh surface water. Fresh surface water abstraction is the volume of water removed from any surface water sources, such as rivers, lakes, reservoirs or rainwater, either permanently or temporarily.	This data item is not applicable to the Bahrain situation. The country does not have surface water resources.
2	Fresh groundwater abstraction	FGWA_02_02	Mm^3/year	Groundwater is the water which is being held in, and can usually be recovered from, or via, an underground formation. All permanent and temporary deposits of water, both artificially charged and naturally, in the subsoil, of sufficient quality for at least seasonal use. This category includes phreatic water-bearing strata, as well as deep strata under pressure or not, contained in porous or fracture soils. Groundwater abstraction includes springs, both concentrated and diffused, which may be subaqueous. Fresh groundwater abstraction is the volume of water removed from any groundwater sources (renewable and nonrenewable, springs, … etc.) either permanently or temporarily.	AEWRD of the MoWMAUP. Time-series data are available for 39 years (1979 - 2017). Challenges include ageing and malfunction of water meters, increasing the need for estimation, and reported data are not smoothly obtained.
3	Freshwater abstracted = FSWA_02_01 + FGWA_02_02	FWA_02_03	Mm^3/year	Water removed from any water source (surface water sources, such as rivers, lakes, reservoirs or rainwater; and groundwater sources) either permanently or temporarily. Includes abstraction by the water supply industry for distribution and direct abstraction by other activities for own use. The volume of water abstracted is broken down by main groups of economic activity of the abstractors (according to ISIC Rev.4) and households.	AEWRD of the MoWMAUP. Only for groundwater. Surface water is not applicable to the Bahrain situation.
4	Freshwater abstraction by water supply industry	FWAWSI_02_04	Mm^3/year	The volume of water abstracted from surface water sources (rivers, lakes, reservoirs etc., including the volume of rainwater collected) and groundwater sources, by economic units whose main activities are the collection and treatment of water and its distribution to households and other users (ISIC 36: Water collection, treatment and supply). The volume of water abstracted by the water supply industry for the operation of irrigation canals is excluded here and should be reported under Freshwater abstracted by agriculture, forestry and fishing.	EWA and Bahrain Petroleum Company (BAPCO). This variable is calculated based on the available data and in accordance with international recommendations for water statistics. Data are available for 1979 - 2017 but require verification.

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Component 2.0: Freshwater Abstraction and Use (FWAU)					
Line	**Variable/Category**	**Variable Code**	**Unit**	**Definition**	**Data source/availability/gaps and challenges**
5	Freshwater abstracted by households	FWAHH_02_05	Mm^3/year	The volume of water directly abstracted from surface water sources (rivers, lakes, reservoirs etc., including the volume of rainwater collected) and groundwater sources by households for own use.	EWA. Disaggregated based on the ISIC, Rev.4. Data are available for 1979 - 2017 but require verification.
6	Freshwater abstracted by agriculture, forestry and fishing.	FWAAG _02_06	Mm^3/year	The volume of water directly abstracted from surface water sources (rivers, lakes, reservoirs etc., including the volume of rainwater collected) and groundwater sources by economic units belonging to ISIC 01-03 for own use. Includes water abstracted by the water supply industry (ISIC 36) for the operation of irrigation canals.	AEWRD of the MoWMAUP. Data disaggregated based on the ISIC, Rev.4. Data are available for years 1979 – 2017.
7	Freshwater abstracted by manufacturing	FWAMG_02_07	Mm^3/year	The volume of water directly abstracted from surface water sources (rivers, lakes, reservoirs etc., including the volume of rainwater collected) and groundwater sources by economic units belonging to ISIC 10-33 for own use.	AEWRD of the MoWMAUP. Data disaggregated based on the ISIC, Rev.4. Data are available for years 1979 – 2017.
8	Freshwater abstracted by industry	FWAIN_02_08	Mm^3/year	The volume of water directly abstracted from surface water sources (rivers, lakes, reservoirs etc., including the volume of rainwater collected) and groundwater sources by economic units belonging to ISIC 351 for own use. Water for hydroelectricity generation (e.g., water behind dams) is excluded.	Included in the manufacturing industry (above). At this stage, available data do not permit further disaggregation.
9	Freshwater abstraction by other economic activities	FWAOEA_ 02_09	Mm^3/year	The volume of water directly abstracted from surface water sources (rivers, lakes, reservoirs etc., including the volume of rainwater collected) and groundwater sources by economic units belonging to all other ISIC categories not specified above for own use.	Included in the manufacturing industry. At this stage, available data do not permit further disaggregation.
10	Desalinated water	DESW_02_10	Mm^3/year	Total volume of water obtained from desalination of (i.e., removal of salt from) seawater and brackish water.	EWA owns useful information system on desalinated water production and use (1979 - 2017). Also disaggregated by sector. Excludes feed groundwater to desalination plants and groundwater used for blending purposes.

Component 2.0: Freshwater Abstraction and Use (FWAU)

Line	Variable/Category	Variable Code	Unit	Definition	Data source/availability/gaps and challenges
11	Reused water	RUW_02_11	Mm^3/year	Used water directly received from another user with or without treatment for further use. It also includes treated wastewater received for further use from treatment plants. Excludes water discharged into a watercourse and used again downstream. Excludes recycling of water within industrial sites.	The Ministry of Works, Municipalities and Urban Planning supply good datasets on this variable. This data item excludes reuse within premises and within industrial plants. Database contains time series data 1970 - 2017. The data are extensively corrected and agreed upon.
12	Imports of water	IOW_02_12	Mm^3/year	Total volume of bulk water that is imported from other countries as a commodity through pipelines or on ships or trucks. Excludes bottled water.	Excludes bottled water. This data item is not applicable to the Bahrain situation.
13	Exports of water	EOF_02_13	Mm^3/year	Total volume of bulk water that is exported to other countries as a commodity through pipelines or on ships or trucks. Excludes bottled water.	This data item is not applicable to the Bahrain situation.
14	Total freshwater available for use	TFWAU_02_14	Mm^3/year	The sum of freshwater abstracted + desalinated water + reused water + imports of water - exports of water.	Based on the availability of the data, total water uses are calculated for 1979 - 2017.
15	Losses during transport	LDT_02_15	Mm^3/year	The volume of water lost during transport between a point of abstraction and a point of use, and between points of use and reuse. Includes leakages and evaporation.	Data are available from 2006 - 2017. Gaps in 2007 but estimated.
16	Total freshwater use	TFWU_ 02_16	Mm^3/year	Water use is the total volume of water, either self-abstracted or received from a water supplier, which is used by final users, such as households or economic activities for their production or consumption processes. The volume of water used is broken down by main groups of economic activity of the final users (according to ISIC Rev. 4) and households.	Total water use was computed based on the available datasets. The database contains time-series data from 1979 - 2017.
17	Freshwater used by Households	FWUHH_02_17	Mm^3/year	The volume of water used by households either supplied by the water supply industry or directly abstracted by households for own use. Water used in the normal functioning of households (e.g., drinking or washing). It includes watering of household gardens but should not include water used for commercial agriculture.	Disaggregated for time series datasets 1979 - 2017.

Cont., Examples for Database Components and Structures

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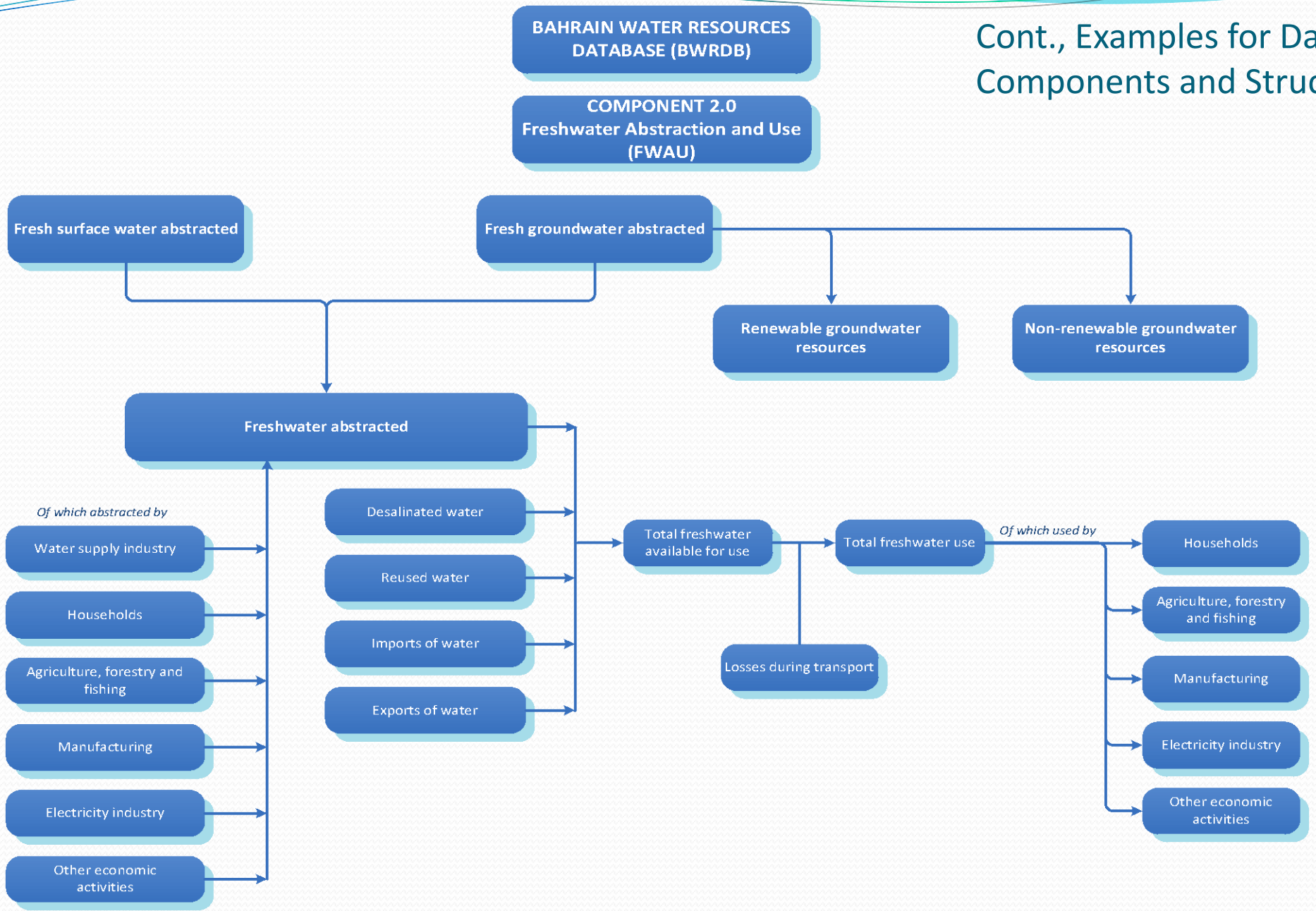
Component 2.0: Freshwater Abstraction and Use (FWAU)					
Line	**Variable/Category**	**Variable Code**	**Unit**	**Definition**	**Data source/availability/gaps and challenges**
18	Freshwater used by Agriculture, forestry, and fishing	FWUAG_02_18	Mm^3/year	Used water directly received from another user with or without treatment for further use. It also includes treated wastewater received for further use from treatment plants. Excludes water discharged into a watercourse and used again downstream. Excludes recycling of water within industrial sites.	Disaggregation performed for the 1979 – 2017 time series data.
19	Freshwater used by manufacturing	FWUMG_02_19	Mm^3/year	The volume of water used for economic activities belonging to manufacturing (ISIC 10-33), either directly abstracted from water sources for own use or supplied by the water supply industry.	Disaggregation performed for the 1979 – 2017 time series data.
20	Freshwater used by electricity industry	FWUEI_02_20	Mm^3/year	The volume of water used for economic activities belonging to the generation, transmission and distribution of electricity (ISIC 351), either directly abstracted from water sources for own use or supplied by the water supply industry. Water for hydroelectricity generation (e.g., water behind dams) is excluded.	Included in the manufacturing category. However, data on industrial use are to be disaggregated for this ISIC classification.
21	Freshwater used by other economic activities	FWUOEA_ 02_21	Mm^3/year		Included in the manufacturing category. Available data do not permit further disaggregation.
00	Long-term annual averages	FWAU_LTAA_00	Mm^3/year	Arithmetic annual averages over at least 30 consecutive years.	To be calculated for each variable for 30 consecutive years or more. Data available for most of the variables.

Cont., Examples for Database Components and Structures



BWRDB Sample Data

Component 2.0: Freshwater Abstraction and Use (FWAU)													
Line	**Category/Variable**	**Variable code**	**Unit**	**LTAA**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
1	Fresh surface water abstraction	FSWA_02_01	Mm^3/year		0	0	0	0	0	0	0	0	0
2	Fresh groundwater abstraction	FGWA_02_02	Mm^3/year		199.9	182.9	169.1	181.8	186.6	178.6	182.2	179.1	159.1
	Renewable fresh groundwater	FGWR_02	Mm^3/year		143.9	126.0	112.4	123.2	128.1	131.5	135.3	132.3	112.6
	Non-renewable fresh groundwater	FGWNR_02	Mm^3/year		56.0	56.9	56.7	58.6	58.5	47.1	46.9	46.8	46.5
3	Freshwater abstracted = FSWA_02_01 + FGWA_02_02	FWA_02_03	Mm^3/year		199.9	182.9	169.1	181.8	186.6	178.6	182.2	179.1	159.1
Of which:													
4	Freshwater abstracted by water supply industry (ISIC 36)	FWAWSI_02_04	Mm^3/year		80.8	69.1	56.6	61.6	71.6	61.2	60.3	56.5	34.7
5	Freshwater abstracted by households	FWAHH_02_05	Mm^3/year		4.1	4.7	3.4	4.2	4.3	5.0	3.7	3.1	2.1
6	Freshwater abstracted by agriculture, forestry, and fishing (ISIC 01-03)	FWAAG_02_06	Mm^3/year		98.7	92.6	90.5	97.9	92.7	93.0	99.1	100.2	104.4
7	Freshwater abstracted by manufacturing (ISIC 10-33)	FWAMG_02_07	Mm^3/year		16.3	16.5	18.6	18.1	18.0	19.4	19.1	19.3	17.9
8	Freshwater abstracted by electrical industry (ISIC 351)	FWAIN_02_08	Mm^3/year		*Included within the manufacturing as available data do not permit further disaggregation by industrial type*								
9	Freshwater abstracted by other economic activities	FWAOEA_02_09	Mm^3/year		*Included within the manufacturing as available data do not permit further disaggregation by industrial type*								
10	Desalinated water	DESW_02_10	Mm^3/year		106.3	145.0	176.0	188.3	189.7	197.0	204.8	219.3	241.6
11	Reused water	RUW_02_11	Mm^3/year		31.6	39.6	38.2	35.4	37.6	36.7	32.4	31.4	29.6
12	Imports of water	IOW_02_12	Mm^3/year		0	0	0	0	0	0	0	0	0
13	Exports of water	EOF_02_13	Mm^3/year		0	0	0	0	0	0	0	0	0

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Component 2.0: Freshwater Abstraction and Use (FWAU)													
Line	**Category/Variable**	**Variable code**	**Unit**	**LTAA**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
14	Total freshwater available for use = FWA_02_03 + DESW_02_10 + RUW_02_11 + IOW_02_12 - EOF_02_13	TFWAU_02_14	Mm^3/year		337.8	367.5	383.2	405.4	414.0	412.3	419.5	429.7	430.3
15	Losses during transport	LDT_02_15	Mm^3/year		4.1	4.5	3.9	5.2	7.1	6.3	5.6	5.1	7.4
16	Total freshwater use = TFWAU_02_14 - LDT_02_15	TFWU_02_16	Mm^3/year		333.7	363.0	379.3	400.2	406.9	406.0	413.9	424.6	422.9
Of which used by:													
17	Households	FWUHH_02_17	Mm^3/year		171.4	198.4	215.7	231.0	239.4	237.6	243.1	252.0	251.1
18	Agriculture, forestry, and fishing (ISIC 01-03)	FWUAG_02_18	Mm^3/year		134.5	136.4	133.1	138.0	135.5	134.9	136.9	137.7	139.2
19	Manufacturing (ISIC 10-33)	FWUMG_02_19	Mm^3/year		27.8	28.2	30.5	31.2	32.0	33.5	33.9	34.9	32.6
20	Electricity industry (ISIC 351)	FWUEI_02_20	Mm^3/year		*Included within the manufacturing as available data do not permit further disaggregation by industrial type*								
21	Other economic activities	FWUOEA_02_21	Mm^3/year		*Included within the manufacturing as available data do not permit further disaggregation by industrial type*								

Notes:

1. *LTAA is the Long -term annual averages only considered meaningful for time-series data of 30 years or more.*
2. *Zero values indicate data items not applicable.*

Next Steps

- Fostering inter-institutional coordination and collaboration by the establishment of a database administrator or inter-sectoral management team (technical steering committee) tasked with specific roles and responsibilities;
- Improve the existing water data national monitoring system in terms of data collection, quality control and processing and reporting capabilities;
- Integrate the existing data management system with GIS-based visualization tools and geospatial data facilities; and
- Integrate the water information system with information-generation applications and web-portal services.

THANK YOU !

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