



OVERVIEW

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INVENTORY OF
SHARED WATER RESOURCES
IN WESTERN ASIA (ONLINE VERSION)



BGR Bundesanstalt für
Geowissenschaften
und Rohstoffe



United Nations Economic and Social Commission for Western Asia

How to cite

UN-ESCWA and BGR (United Nations Economic and Social Commission for Western Asia; Bundesanstalt für Geowissenschaften und Rohstoffe). 2013. Inventory of Shared Water Resources in Western Asia. Beirut.



OVERVIEW

INTRODUCTION TO THE INVENTORY

Over 40% of the world's population resides in shared water basins.¹ Human settlements, agriculture and industry have proliferated along shared surface waters that have been the cradles of civilizations, while increased capacity for groundwater abstraction has created new opportunities for development and expansion around transboundary aquifers. There is a general consensus in the international community that there are 263 shared river basins and over 300 transboundary aquifers and aquifer systems in the world.

Shared water resources provide an essential source of freshwater, especially in water-scarce regions. Water scarcity is a fundamental challenge to sustainable development in arid and semi-arid regions where renewable freshwater resources at the national level are insufficient to satisfy growing needs. As water scarcity intensifies due to increasing socio-economic demands and environmental pressures, so does the dependency of states on shared water resources needed to complement domestic supplies. This situation increases interdependencies between riparian states whereby changes in the management of a transboundary water resource in one country can have significant implications for water quantity or quality in a neighbouring country situated downstream. Decision-making regarding the management of these resources can thus have important implications for regional stability, socio-economic development, environmental protection, as well as peace and security. Cooperation across borders is thus necessary to support the integrated management of shared water resources within

a regional context.² This requires accurate, up-to-date information on shared surface and groundwater systems to inform regional dialogue and debate regarding the management of these precious resources.

There is a prevailing perception that shared water resources in Western Asia have been extensively studied. Water scarcity and water security challenges are regularly evoked by political theorists, analysts and members of the international community engaged in the geopolitical discourse that has contextualized the management of shared water resources and inter-state relations in the region for decades. However, while there is an extensive literature on a few surface water basins, very little has been written on shared water resources in Western Asia as a whole.



Shepherd near Afrin, Syria, 2009. Source: Andreas Renck.



Furthermore, no publication has sought to study all the shared surface and groundwater resources in the region in an integrated and comprehensive manner. The research that has been conducted has been limited in scope or drawn from dated documentation, assessments and maps that do not adequately represent the state of knowledge regarding these shared resources today.

This Inventory of Shared Water Resources in Western Asia is the first systematic effort to catalogue and characterize shared surface water and groundwater systems throughout the region. Its main purpose is to provide a sound scientific basis for informing discussion and fostering dialogue on these precious resources that have become increasingly important to sustain development in an era of growing demand and dwindling supply. To do so, the Inventory identifies all shared water resource systems within the region and provides a comprehensive, descriptive analysis of each basin based on the following guiding questions:

- Where are the shared water resources?
- What is the status of these resources, at present and in a historical context?
- How is the water being used?
- What cooperative arrangements and structures are in place?

Conceptually, the Inventory is situated at the science-policy interface, with two sets of objectives. The scientific objectives aimed at assessing shared water resources in the region are:

- To identify shared surface and groundwater resources.
- To document the state of shared water resources and their use.
- To improve the knowledge base and facilitate access to information on shared water resources.

The policy and development objectives aimed at enhancing cross-border cooperation on shared water resources are:

- To raise awareness among decision-makers, experts and the general public.

- To stimulate an informed discussion within and between riparian countries.
- To support regional processes towards improved dialogue and cooperation over shared water resources.

The result is a comprehensive reference document of shared surface and groundwater resources in Western Asia that encompasses water resources that are shared between Arab states and between Arab and non-Arab states situated in the Western Asia study area.

The Inventory targets a wide audience of experts from water, environment and other sectors, including decision-makers, government representatives, academia, donors, specialized agencies, international and non-governmental or civil society organizations.

BOX 1 Shared vs. Transboundary – A Question of Terminology

Water bodies that cross political borders are most commonly described as “international” or “transboundary”.^a The 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki Convention) adopted by the United Nations Economic Commission for Europe (UNECE) defines “transboundary waters” as “any surface or ground waters which mark, cross or are located on the boundaries between two or more States”.^b The term “international” has been used to characterize the specialized focus on water in the international law community, and also tends to encompass marine water systems.

The term “shared” has been widely used in the context of efforts by the international community to foster cooperation over natural resources that cross political borders. The adoption of United Nations General Assembly Resolution 3129 (XXVIII) on 13 December 1973 entitled “Co-operation in the field of the environment concerning natural resources shared by two or more States” led to the development of guiding principles to support the formulation of bilateral and multilateral agreements regarding natural resources shared by two or more States.^c In 2002 the United Nations International Law Commission initiated the Shared Natural Resources of States programme, which issued the Draft Articles on the law of transboundary aquifers in 2008.

In the Arab region, the term “shared” is regularly used in inter-governmental forums that seek to promote cooperation and integration between Arab States. While the League of Arab States has adopted no official decision stipulating the adoption of this term, the Arab Ministerial Water Council established in 2008, commonly uses “shared” in its resolutions. Moreover, the “Arab Strategy for Water Security in Arab Region to Meet the Challenges and Future Needs for Sustainable Development 2010-2030” approved in 2011 also adopted the term “shared” for both surface and groundwater resources; however, this does not imply an allocation for the sharing of the resource by the riparian countries.^d The Arabic term for “transboundary” is not commonly used in the context of water resources. The Inventory therefore consistently refers to “shared” water resources, which may here be considered synonymous with “transboundary” in its English-language context.

[a] UNECE, 1992, UNILC, 2008, United Nations General Assembly, 1997.

[b] UNECE, 1992.

[c] United Nations General Assembly Resolution 34/186 of 18 December 1979 (United Nations General Assembly, 1979).

[d] LAS, 2010; LAS, 2011a; LAS, 2011b, LAS, 2012. In December 2011, Saudi Arabia formally suggested the use of the term “transboundary” as an alternative to “shared” in the “Legal Framework of Shared Water Resources in the Arab Region”



Methodology & Information Sources

The Inventory started as a desk study by the German Federal Institute for Geosciences and Natural Resources (BGR) and the United Nations Economic and Social Commission for Western Asia (ESCWA) in 2009 following a request by the ESCWA Committee on Water Resources to build national capacity for the integrated management of shared water resources in ESCWA member countries.³ An integrated and iterative process of development, review, consolidation and consultation with regional and international experts and country representatives enhanced the study to result in a comprehensive reference on shared water resources in the Western Asia region.

However, while the preparation of the Inventory was initiated and conducted in consultation with the ESCWA Committee on Water Resources, it is not formally tied to a binding inter-governmental agreement or monitoring mechanisms, such as a regional convention on shared water resources with associated reporting requirements. Preparation of the Inventory under such a framework would have provided an umbrella for the official exchange and submission of information on the shared basins.⁴ Rather, country participation in the process of preparing the Inventory was voluntary and based on the spirit of cooperation. Country submissions thus varied significantly in terms of scope and level of detail and the outcome is not necessarily based on consensus.

In line with its intended character as a technical reference document, the Inventory is primarily descriptive in its nature and writing style. The Inventory is the outcome of an unbiased scientific process and all information and data in the chapters are duly referenced to allow for independent verification. However, the authors of the Inventory cannot be held responsible for the accuracy or correctness of data taken from published sources or provided by countries. Similarly, the involvement of country representatives in the compilation of the Inventory does not imply their official endorsement of the report or the information presented therein, except where explicitly stated. Unresolved issues are dealt with by presenting the different points of view, by including apparently contradictory information or by offering multiple, differing values for certain parameters.

The different research and production phases of the Inventory can be subdivided into three stages outlined below. As the chapters were not produced simultaneously or by the same author, the Inventory team adopted an iterative approach, which allowed for adjustments and modifications in different chapters throughout the process. For example, findings generated during later stages were often used to refine the initial chapters and templates or to modify the delineation and description of shared surface or groundwater resources.



Agriculture in the area of Azraq, Jordan, 2008. Source: David L. Kennedy, Aerial Photographic Archive for Archaeology in the Middle East.

**BOX 2** Involvement of ESCWA Member Countries

ESCWA member countries have been involved in all stages of preparation of the Inventory. This consultative process mainly took place through the ESCWA Committee on Water Resources, which is an inter-governmental committee composed of senior technical and managerial staff of sector ministries in ESCWA member countries responsible for water resources management. The Committee meets biannually and approves ESCWA's biannual work programme in the water sector. The recommendations of the Committee are subsequently reviewed and approved by the ESCWA Technical Committee and the ESCWA ministerial session, which is the Commission's highest political body. The Committee's involvement in the consultation process for the Inventory consisted of the following phases:

ESCWA Committee on Water Resources – Eighth session (December 2008)

The Committee requested ESCWA to continue to provide technical support to its member countries to build national capacity in the domain of integrated water resources management, especially in the area of shared surface and groundwater resources, and to update an assessment of legal and institutional tools for shared water resources management by itself or in coordination with BGR and other regional and international organizations.^a

ESCWA Committee on Water Resources – Ninth session (March 2011)

Following a presentation of the scope, status and preliminary findings of the Inventory by the ESCWA-BGR Cooperation at the ninth session of the Committee on Water Resources, the Committee called for the nomination of focal points in ESCWA member countries to support the further preparation and finalization of the Inventory and encouraged governments to consider its outcomes.^b

Nomination of Inventory focal points (April-September 2011)

After ESCWA sent a note verbale to Committee members calling for the nomination of focal points, nominations were received between April and September 2011. Many of the nominated focal points were also members of the ESCWA Committee on Water Resources, and were thus already familiar with the Inventory process.

Regional Consultation Meeting with member countries (October-December 2011)

Focal points gathered in Beirut from 29 November to 1 December 2011 for a briefing on progress achieved thus far on the preparation of the Inventory and to encourage an open and transparent discussion among riparian countries on the preliminary findings. In preparation for the consultative meeting, an information note on the preliminary overall findings of the Inventory was sent to the countries in early November 2011 together with dedicated questionnaires. Focal points and experts from 8 of the 13 countries that had nominated focal points attended the meeting. Participants reiterated their support for the Inventory and agreed to submit the requested data.

Follow-up and informal consultations (starting December 2011)

Countries that did not participate in the meeting were informed of its outcomes in early December 2011. The Inventory team went on a number of missions to member countries to follow up on data submission and for further clarifications and discussions of the preliminary findings, the methodology applied and next steps in the consultation process. Conferences at ESCWA and in the region as well as other missions allowed for further informal meetings with focal points and experts. Upon request of member countries, the deadline for submission of information was extended twice.

Chapter comments (May 2012-December 2012)

Focal points received the completed draft basin chapters for comment. Draft chapters were released only to the riparian countries of a shared basin. Countries were asked to submit their comments on each basin chapter within a month of receipt of the chapter. Focal points were encouraged to consult other experts and authorities in their country in order to allow for a comprehensive review.

Final Consultation on the Inventory (February-March 2013)

All nominated focal points as well as all members of the ninth session of the ESCWA Committee on Water Resources received the complete Inventory in layout form for final comments. The Inventory was presented to the members of the ESCWA Committee on Water Resources during its tenth session in March 2013 and invited to provide their final comments prior to its publication.

(a) UN-ESCWA, 2008.

(b) UN-ESCWA, 2011.



Mukalla, Yemen, 2000. Source: Kebnekaise.



PREPARATORY PHASE – TRANSLATING CONCEPT INTO STRUCTURE

The core themes, content, structure and overall design were developed based on the overall concept for the Inventory aimed at providing a comprehensive reference document on shared water resources in the study area. Core themes were selected to allow for a comprehensive characterization of the shared water resources (hydrology and hydrogeology), prevailing water uses (water resources management and use) and riparian agreements and cooperation over these water resources (agreements, cooperation and outlook).

Water resources were identified and described following the basin approach, with each identified shared basin generally included in a separate chapter in the Inventory. A river “basin” hydrologically consists of an area of land in which all surface water drained by the river system is conveyed to the same outlet; topography is the key element affecting the boundary of the basin. Similarly, a groundwater basin is a physiographic unit made up of one large aquifer or several connected aquifers delimited by a groundwater divide, in which groundwater flows to a common outlet.

In practice, however, the “basin” terminology and approach was not applicable to many shared groundwater resources covered in this Inventory due to the specific hydrogeological context, scale issues or the lack of available information to determine groundwater basin boundaries. In these cases, the scope of chapters on shared aquifer systems was adapted accordingly, as explained in the ‘Overview & Methodology: Groundwater’ chapter, which introduces Part II.

In other cases, the chapter structure was adapted in order to emphasize certain aspects that would otherwise be overlooked, for example the tributaries to the larger transboundary Euphrates and Tigris Rivers (see ‘Overview & Methodology: Surface Water’ chapter, which introduces Part I).

For simplicity’s sake, a shared water body is referred to as a “basin” and a chapter in the Inventory on a shared water body is referred to as a “basin chapter”, regardless of whether they represent basins in the narrow hydrological or hydrogeological sense.

Each basin chapter contains significant amounts of technical information needed to identify, delineate and characterize the basin. This is particularly the case for groundwater chapters (Part II).

The basin chapters have a unified structure and table of contents based on the core themes of the Inventory, with separate templates for

surface and groundwater. The chapter templates facilitate direct thematic access to the content, underlining the descriptive character of the Inventory as a reference work. In practice, however, numerous interactions exist between surface and groundwater resources in their natural environment, between consumptive and non-consumptive water uses and other water development projects implemented in the basins. The chosen structure of the Inventory may not always fully reflect the complexity of these interdependencies and readers may need to consult several sub-sections of a basin chapter to review these linkages. Cross-references and box texts with additional information help readers in this navigation.

Other studies have used more advanced analytical tools and methodologies for structuring assessments of shared water resources, such as the DPSIR framework,⁵ but data availability for this first assessment was largely insufficient for such analysis. A more causal, analytical assessment of water issues in the identified shared basins may take place as part of future updates of the Inventory.

RESEARCH AND IDENTIFICATION OF BASINS

Information on shared surface and groundwater resources was initially collected and summarized from ESCWA reports, regional literature, scientific publications, country papers, national and regional maps and data sets, satellite imagery, media reports and other grey literature. The research process was markedly different for the surface water and groundwater sections of the Inventory.

Generally speaking, the shared rivers in the study region were already known and a wealth of information was already publicly available for many of the shared basins albeit often outdated or limited to specific issues. For each basin, information packages were compiled according to the core themes and chapter templates, which were later used, where necessary, as a basis for consultation with countries (Box 2).

On the other hand, groundwater resources in the study region had not previously been catalogued across borders, nor was there a common methodology adapted to this purpose and the specific conditions of the region. Research for “Part II: Groundwater” therefore started with the screening of all available geological and hydrogeological information and its interpretation in view of identifying potentially shared aquifers and aquifer systems (see ‘Overview & Methodology: Groundwater’ chapter). The findings were discussed internally and with a panel of regional and international experts, most notably during a regional expert



consultation meeting held in Beirut in May 2011. The experts were also involved in a peer review of data sets and, later on, of chapter drafts with a focus on overall coherence and integrity, and possible shortcomings and gaps. Where relevant, they contributed references and technical information.⁶ Modified information packages were then compiled and used in the consultation with countries (Box 2).

Riparian countries received the modified information packages for the surface and groundwater chapters with overview maps, consolidated fact sheets and bibliographies,⁷ as well as specific requests regarding missing data and other information needed to complete the chapters. Any relevant information subsequently received from the countries was incorporated into the chapter drafts.

DRAFTING AND REVIEW

Based on the revised information packages, full basin chapters were drafted, together with all supporting figures, tables and maps. Where no information was received from countries, information from the literature was used. In some cases additional proxy data was included to compensate for the lack of information on some of the core themes, such as surface and groundwater abstraction and use. For example, in some cases national agricultural statistics on production and irrigated areas were included to characterize water use trends in predominantly agricultural basins.

All draft chapters were made available to ESCWA member countries for comment and the Inventory team thoroughly reviewed all substantive comments from countries.

Comments and additions received before the deadline were usually directly incorporated and countries received feedback or clarification where necessary or requested. Where differing

or contradictory information was obtained from different sources, the different data sets and arguments were all included to reflect a range of findings and viewpoints.

Chapter drafts were also distributed for review to selected experts, many of whom had already been consulted in earlier stages of the research process. The final drafts were formally edited and proofed according to UN standards.

BOX 3 Spelling of Names

In general, the spelling of all place names, as well as names of rivers, lakes, seas, mountains and other geographical features, is based on the United Nations Multilingual Terminology Database (UNTERM) and the ESCWA Internet Terminology and Reference System (ESCWATerm).^a However, as geographical features are often not included in these two databases, many Arabic names were transliterated and cross-checked with references in the literature.

Two geographical names are subject to regular controversy in the region: "Persian Gulf" and "State of Palestine".

In accordance with the two editorial directives issued by the United Nations Secretariat in 1994 and 1999, the Inventory consistently uses the term "Persian Gulf" instead of "Arabian Gulf".

The text also consistently refers to "Palestine" instead of "Palestinian territories" or "occupied Palestinian territories" as Palestine is a member country of ESCWA.^b This is also in accordance with the 29 November 2012 vote by the United Nations General Assembly that recognizes Palestine as a non-member observer state of the United Nations. Following this vote it was decided that the United Nations Secretariat will use the designation "State of Palestine" in all official United Nations documents.^b However, in doing so, "State of Palestine" would be used only in instances where the full name of the country is applied; otherwise, the term "Palestine" would be used,^b as is the case when referring to "Jordan" rather than "Hashemite Kingdom of Jordan".

It is also important to clarify the use of the geographical name "Gulf of Oman". The Government of the Sultanate of Oman decided to officially designate it as the "Sea of Oman" in 2010,^c and has designated it as such in its national documents and newly issued maps.^d However, the term "Gulf of Oman" was used throughout the Inventory in accordance with the terminology used in all maps issued to date by the United Nations Cartographic Section.^e

(a) UNTERM, 2012; UNOV, 2012.

(b) UN-DGACM, 2012.

(c) Embassy of the Sultanate of Oman in Beirut, 2010.

(d) Ministry of Regional Municipalities and Water Resources in Oman, 2011.

(e) United Nations Cartographic Section, 2012.



Readers' Guide

This introduction is followed by an overview of shared water resources in Western Asia, which details the scope of the region under study, as well as a list of key findings of the Inventory. The core report is then divided in two parts: Surface Water (Part I) and Groundwater (Part II). Each part opens with an overview and methodology chapter, which is followed by descriptive chapters on each of the shared water basins (basin chapters). The Inventory features 9 surface water basin chapters and 17 groundwater basin chapters. They are designed to be read as stand-alone chapters as they are available in this form on the Inventory website.

All basin chapters open with an overview map, an overview table highlighting main facts and figures, and a summary of the most relevant issues, especially regarding water use, trends and management. More detailed information

is then found in the main text, which varies in length depending on the availability of information. Each basin chapter concludes with a bibliography.

Many parts of the basin descriptions, especially the sections on 'Geography', 'Water Resources Management', and 'Agreements, Cooperation and Outlook', are generally written in a non-technical language to be accessible to a wide audience of interested readers.

The basin chapters also contain specialized technical information, especially in the 'Hydrology/Hydrogeology' sub-sections, which are aimed at a more specialized technical audiences and experts. An icon coding scheme allows readers to identify and navigate between different chapter sections.

BOX 4 The Map Production Process

The production of 60 maps for the Inventory was GIS based using ArcGIS 9.3 software. The following sources of information were used in map production:

- Administrative boundaries and coastlines come from UNGIWG, 2012.
- Capitals and selected cities are taken from ESRI, 2002 and, wherever necessary, added based on Google Earth coordinates. The selection of cities and other geographical landmarks was mainly based on geographical references used in the chapter texts.
- Stream network and drainage basins for the Western Asia region were taken from different sources. As a starting point, the FAO data set 'Rivers of the Near East' was used, which is derived from the HydroSHEDS data set.^a Further stream network data was added, removed and/or modified manually based on the original 15-second HydroSHEDS data set, regional and national maps, and Google Earth.
- Lake polygons were taken from a 2007 data set by GRDC, 2011 and were modified by BGR during the same year. Smaller reservoir lakes were digitized using Google Earth.
- The location of dams and canals was digitized from Google Earth and crossed-checked with entries in reports or other documents.
- Monitoring and climate stations were included based on their coordinates published in the respective literature.
- Areas marked as "zone of agricultural development" are taken either from FAO, 2009 or were approximated using green cover areas in Google Earth.
- Wetlands and sabkhas were taken from basin studies and maps, from UN-ESCWA and BGR, 1999b or were digitized from Google Earth.
- Mean annual precipitation was taken from WorldClim, 2011, an interpolated global climate data set at 1 km² spatial resolution that combines meteorological data (1960-2000) and the global SRTM elevation data set.
- Population density data was taken from CIESIN, 2010 data set with a native grid cell resolution of 2.5-5 km, produced by the Center of International Earth Science Information Network, based on its 2004 statistics.
- Outcrops and subsurface extent of geological formations as well as major structural features were taken from various regional and national maps, including the Water Atlas of Saudi Arabia,^b the Geological Map of the Middle East,^c the International Geological Map of the Middle East^d and the maps on Paleogene Aquifers of the Arabian Peninsula.^e
- The Middle East Geologic Map Series (MEG maps)^f were used extensively for subsurface considerations of certain aquifer formations and particularly the calculation of depth to top of the aquifer as part of the exploitability assessment.^g
- Smaller-scale structural geological features, wells, groundwater basin boundaries and other relevant features were taken from the literature as available. Examples include UN-ESCWA et al., 1996, Jassim and Goff, 2006, ACSAD, 1983, and other national reports.
- A map relief (hillshade) background layer was prepared and used at two different resolutions depending on map scale. The low resolution relief was derived from the European Digital Elevation Model "eu-DEM-15hill". The high resolution relief was prepared based on SRTM data processed by the CGIAR-Consortium for Spatial Information.^h

(a) HydroSHEDS stands for "Hydrological data and maps based on Shuttle Elevation Derivates at multiple Scales". It has been developed by the Conservation Science Program of World Wildlife Fund (WWF), in partnership with the U.S. Geological Survey (USGS), the International Centre for Tropical Agriculture (CIAT), The Nature Conservancy (TNC), and the Center for Environmental Systems Research (CESR) of the University of Kassel, Germany (USGS, 2010).

(b) Ministry of Agriculture and Water in Saudi Arabia, 1984.

(c) Aghanabati, 1993.

(d) CGMW, 2009.

(e) UN-ESCWA and BGR, 1999a.

(f) Christian, 2000.

(g) See 'Overview & Methodology: Groundwater' chapter for further information on the process and criteria used in the exploitability assessment.

(h) CGIAR-CSI, 2008.



Notes

1. UN-ESCWA, 2009.
2. Ibid., 2012.
3. Ibid., 2008.
4. Such as the UNECE Assessment of Transboundary Waters in Europe (UNECE, 2007; UNECE, 2011), which was implemented by the Working Group on Monitoring & Assessment under the secretariat to the Helsinki Convention of 1992.
5. DPSIR is a causal framework for describing the interaction between society and the environment, built on the following components: Driving forces, Pressures, States, Impacts and Responses. This framework has been adopted by the European Environment Agency and has also been applied by UNECE in both assessments of transboundary waters in Europe.
6. All experts and contributors are listed in the contributors section.
7. Relevant countries are all countries that were identified to share the watercourse, the surface water basin or the aquifer or aquifer system.



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