TWAP
TRANSBOUNDARY WATERS ASSESSMENT PROGRAMME

Transboundary Waters: A Global Compendium

Water System Information Sheets: Eastern & Central Asia

Volume 6 - Annex J: Eastern & Central Asia

UNEP

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Volume 6-Annex J

Transboundary Waters: A Global Compendium

Water System Information Sheets: Eastern & Central Asia

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UNEP-DHI PARTNERSHIP Centre on Water and Environment

UNEP · DHI

GLOBAL IGBP CHANGE International Geosphere-Biosphere Programme

IUCN

SIWI

CUNY The City University of New York

OSU Oregon State University

Center for International Earth Science Information Network, Earth Institute | Columbia University

CESR Center for Environmental Systems Research

Delta Alliance

Assessment Team: Large Marine Ecosystems

UNESCO United Nations Educational, Scientific and Cultural Organization · Intergovernmental Oceanographic Commission

GLOBAL IGBP CHANGE International Geosphere-Biosphere Programme

NOAA

GESAMP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection

DALHOUSIE UNIVERSITY Inspiring Minds

Center for Marine Assessment and Planning, UCSB

UNEP WCMC

CERMES

UBC · Sea Around Us

TAT Tokyo University of Agriculture and Technology

Assessment Team: The Open Ocean

UNESCO United Nations Educational, Scientific and Cultural Organization · Intergovernmental Oceanographic Commission

GOOS Global Ocean Observing System

WCRP World Climate Research Programme

GACS Global Alliance of CPR Surveys

PML Plymouth Marine Laboratory

CERMES

UBC · Sea Around Us

Center for Marine Assessment and Planning, UCSB

GESAMP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection

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Administrative Boundaries: Source of administrative boundaries used throughout the assessment: The Global Administrative Unit Layers (GAUL) dataset, implemented by FAO within the CountrySTAT and Agricultural Market Information System (AMIS) projects.

Contents (Volume 6, Annex J)

Preface

The Global Environment Facility (GEF) approved a Full Size Project (FSP), "A Transboundary Waters Assessment Programme: Aquifers, Lake/Reservoir Basins, River Basins, Large Marine Ecosystems, and Open Ocean to catalyze sound environmental management", in December 2012, following the completion of the Medium Size Project (MSP) "Development of the Methodology and Arrangements for the GEF Transboundary Waters Assessment Programme" in 2011. The TWAP FSP started in 2013, focusing on two major objectives: (1) to carry out the first global-scale assessment of transboundary water systems that will assist the GEF and other international organizations to improve the setting of priorities for funding; and (2) to formalise the partnership with key institutions to ensure that transboundary considerations are incorporated in regular assessment programmes to provide continuing insights on the status and trends of transboundary water systems.

The TWAP FSP was implemented by UNEP as Implementing Agency, UNEP's Division of Early Warning and Assessment (DEWA) as Executing Agency, and the following lead agencies for each of the water system categories: the International Hydrological Programme (IHP) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) for transboundary aquifers including groundwater systems in small island developing states (SIDS); the International Lake Environment Committee Foundation (ILEC) for lake and reservoir basins; the UNEP-DHI Partnership – Centre on Water and Environment (UNEP-DHI) for river basins; and the Intergovernmental Oceanographic Commission (IOC) of UNESCO for large marine ecosystems (LMEs) and the open ocean.

The five water-category specific assessments cover 199 transboundary aquifers and groundwater systems in 43 small island developing states, 204 transboundary lakes and reservoirs, 286 transboundary river basins; 66 large marine ecosystems; and the open ocean, a total of 756 international water systems. The assessment results are organized into five technical reports and a sixth volume that provides a cross-category analysis of status and trends:

Volume 1 – ***Transboundary Aquifers and Groundwater Systems of Small Island Developing States: Status and Trends***
Volume 2 – ***Transboundary Lakes and Reservoirs: Status and Trends***
Volume 3 – ***Transboundary River Basins: Status and Trends***
Volume 4 – ***Large Marine Ecosystems: Status and Trends***
Volume 5 – ***The Open Ocean: Status and Trends***
Volume 6 – ***Transboundary Water Systems: Crosscutting Status and Trends***

A ***Summary for Policy Makers*** accompanies each volume.

Volume 6 presents a unique and first global overview of the contemporary risks that threaten international water systems in five transboundary water system categories, building on the detailed quantitative indicator-based assessment conducted for each water category. As a supplement to Volume 6, this global compendium of water system information sheets provides baseline relative risks at regional and system scales. The fact sheets are organized into 14 TWAP regions and presented as 12 annexes. Volume 6 and the compendium are published in collaboration among the five independent water-category based TWAP Assessment Teams under the leadership of the Cross-cutting Analysis Working Group, with support from the TWAP Project Coordinating Unit.

The technical teams of the Transboundary Waters Assessment Programme(TWAP) assessed transboundary aquifers, lakes & reservoirs, river basins, and large marine ecosystems and prepared information (fact) sheets for water systems that were evaluated. Each fact sheet provides basic geomorphological information and presents baseline values of quantitative indicators that were used to establish relative risk levels. The water system fact sheets are organized into 14 TWAP regions that were used in the Crosscutting Analysis described in Volume 6. The regional compilations are presented as 11 annexes (A-K) of a global compendium, combining Southern & Southeastern Asia into one annex (I), and the Pacific Island Countries, Australia & Antarctica into another (Annex K). Each annex highlights contemporary regional risks as well as water system-specific risks. The annexes are:

Annex A. Transboundary waters of Northern America
Annex B. Transboundary waters of Central America & the Caribbean
Annex C. Transboundary waters of Southern America
Annex D. Transboundary waters of Eastern, Northern & Western Europe
Annex E. Transboundary waters of Eastern Europe
Annex F. Transboundary waters of Western & Middle Africa
Annex G. Transboundary waters of Eastern & Southern Africa
Annex H: Transboundary waters of Northern Africa & Western Asia
Annex I: Transboundary waters of Southern & Southeastern Asia
Annex J: Transboundary waters of Eastern & Central Asia
Annex K: Transboundary waters of the Pacific Island Countries, Australia & Antarctica

In the case of the open ocean, which is the largest transboundary water system of planet earth, selected quantitative indicator maps prepared by the Open Ocean Assessment Team, are compiled in Annex L to highlight the contemporaneous state of the global ocean.

Annex L: Selected indicator maps for the open ocean

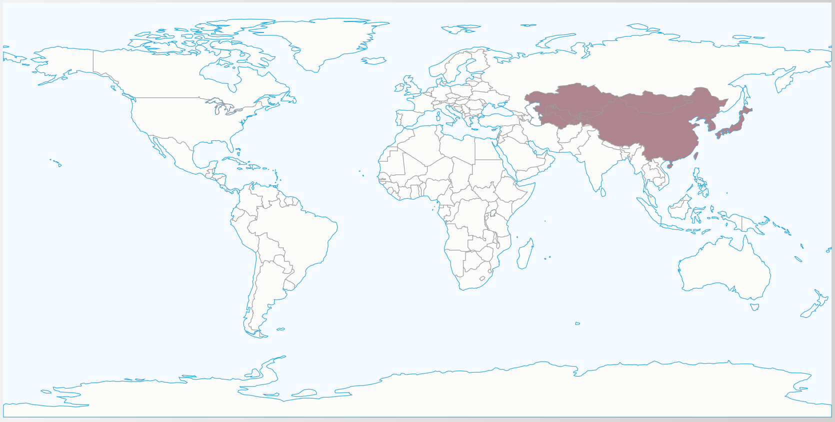
All information sheets and indicator maps for the open ocean may be downloaded individually from the following websites:

Transboundary Aquifers: http://twapviewer.un-igrac.org
Transboundary Lakes/ Reservoirs: http://ilec.lakes-sys.com/
Transboundary River Basins: http://twap-rivers.org
Large Marine Ecosystems: http://onesharedocean.org
Open Ocean: http://onesharedocean.org

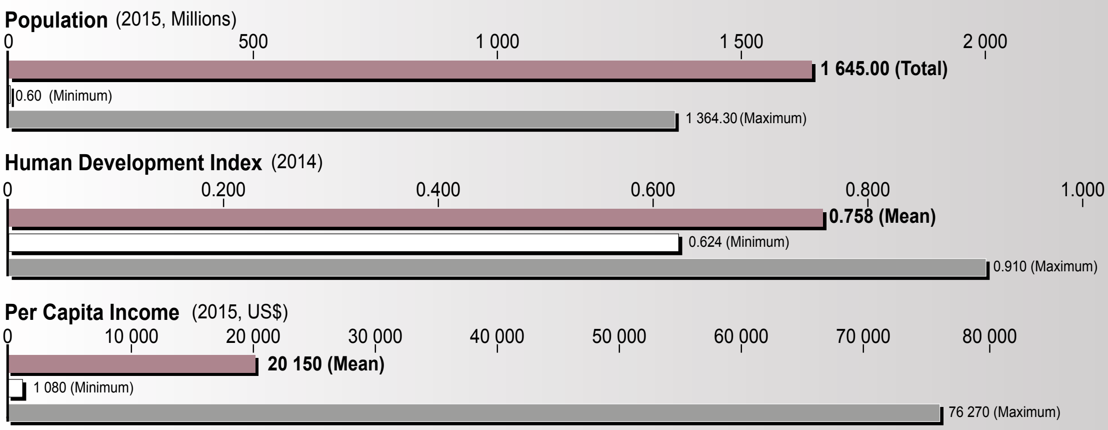
All TWAP publications are available for download at http://www.geftwap.org

Over the long term, it is envisioned that these baseline information sheets will continue to be updated by future assessments at multiple spatial and temporal scales to better track the changing states of transboundary waters that are essential in sustaining human wellbeing and ecosystem health.

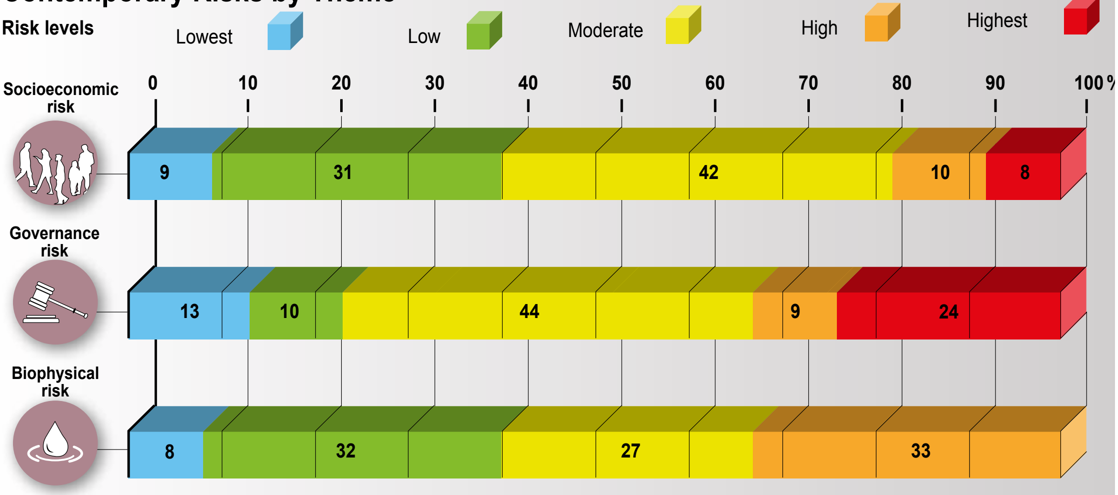
TRANSBOUNDARY WATERS: EASTERN & CENTRAL ASIA



The region has an average Human Development Index of 0.758, belonging to the High HDI group with a total population of 1645 million in 2015. Contemporary risks of water systems by water category and theme expressed as percentages are shown at top right. Pooling across 58 transboundary water systems (bottom left), 60% suffer from moderate to highest socioeconomic risk; 77% from moderate to highest governance risk; and 60% from moderate to high biophysical risk. On average, the region's transboundary waters (bottom right) are at moderate socioeconomic, governance and biophysical risks. LMEs are at high risk across risk themes; both aquifers and river basins are at moderate risk, and lakes are at low risk.

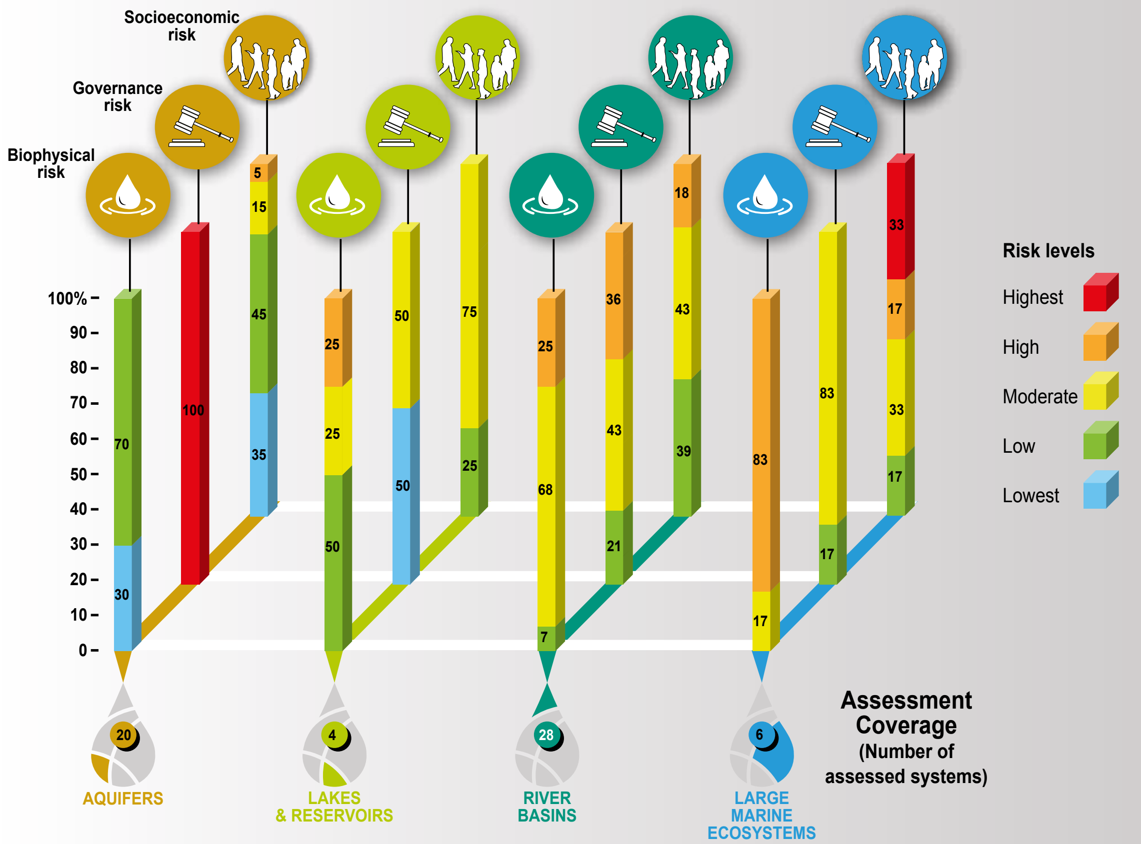


Contemporary Risks by Theme

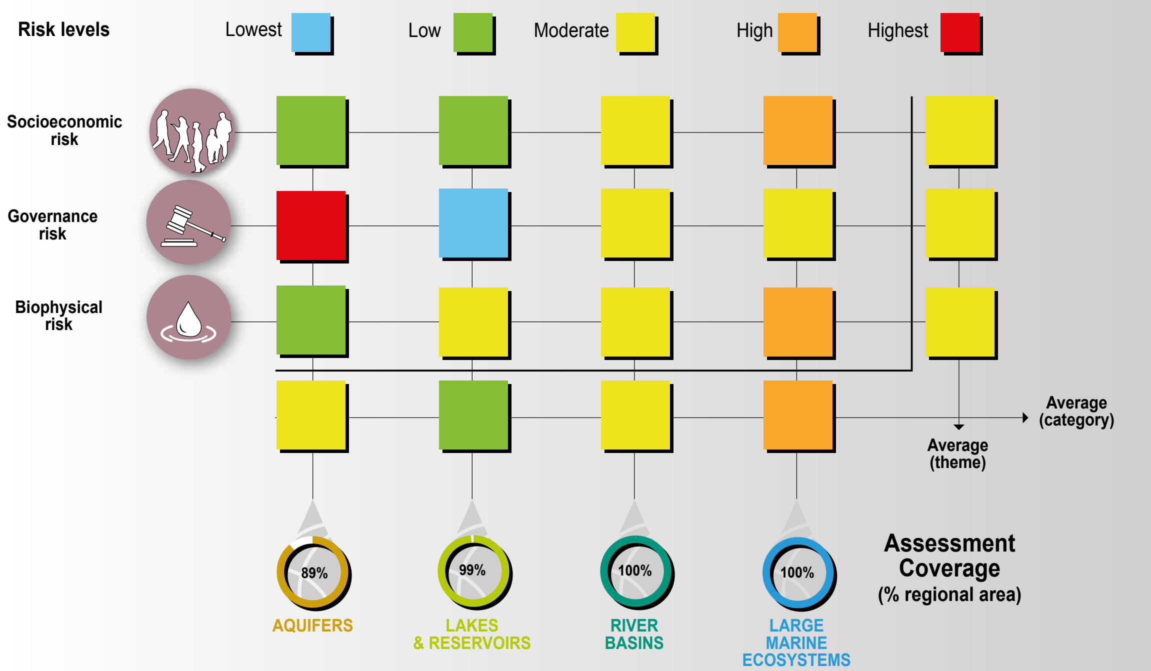


Regional Risks by Water Category

Contemporary Risks by Water Category



Average Risks



1. Amu-Darya
2. Birata-Urgench
3. Buir Nurr-Khalkh River Aquifer
4. Dankhan Khudgiin Sair Aquifer
5. Delger River
6. Downstream of Lancang River
7. Ertix River
8. Hong River Basin
9. Ili River
10. Irtysh-Obsky
11. Karst Aquifer of Upper Zuojiang Valley
12. Middle Heilongjiang-Amur River Basin
13. Nu River Valley
14. Pre-Caspien
15. Shishhid River Aquifer
16. South-Pred-Ural Aquifer
17. Syr Daria
18. Syrt
19. Tacheng Basin/ Alakol
20. Yalu River Basin
21. Yalu River Valley
22. Yenisei Upstream
23. Zeya River Basin

AS35 - Amu-Darya

Geography

Total area TBA (km^2): 190 000

No. countries sharing: 3

Countries sharing: Uzbekistan, Kazakhstan, Turkmenistan

Population: 270 000

Climate Zone: Arid

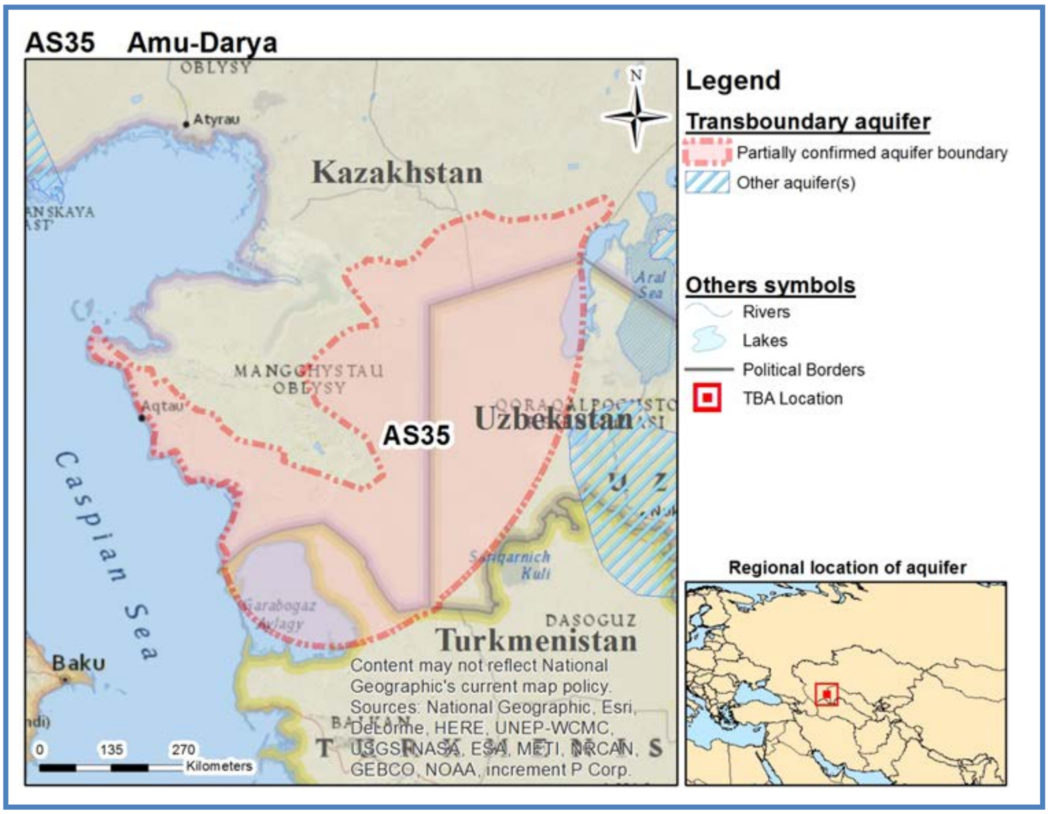
Rainfall (mm/yr): 120

Hydrogeology

Aquifer type: Multiple layers hydraulically connected

Degree of confinement: Aquifer mostly confined, some parts unconfined

Main Lithology: Sediment – sands, sedimentary rocks - sandstones



No Cross-section was provided

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS35 - Amu-Darya

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
Uzbekistan			<5		0		2		D	E
Kazakhstan							1			
Turkmenistan							1			
TBA level							**1**			

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).

(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.

(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).

(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.

(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).

(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
Kazakhstan	5	2200	-17	-26	33	37	3	37
Turkmenistan	110	230 000	-21	-31	25	40	2	0
Uzbekistan	13	18 000	-25	-37	92	92	0	0
TBA level	**23**	**16 000**	**-19**	**-29**	**38**	**49**	**3**	**37**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
Kazakhstan	0	2	20	35	4	2	2
Turkmenistan	0	1	26	43	<1	0	0
Uzbekistan	0	1	31	51	1	0	0

AS35 - Amu-Darya

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
TBA level	**0**	**2**	**22**	**38**	**1**	**0**	**0**

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
Uzbekistan	10	10	1500	Aquifer Mostly confined, but some parts unconfined	Sediment - Sand	Low Primary porosity intergranular porosity	No Secondary porosity	
Kazakhstan								
Turkmenistan								
TBA level								

* Including aquitards/aquicludes
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Aquifer description

Only Kazakhstan has reported and the description below is based on that country's information.

Aquifer geometry
This is a multi 3-layered system that is hydraulically connected. According to the USSR hydrogeological zoning system, this area is part of the major Ustyurt artesian basin. The average depth to the piezometric water level is 10m within Kazakhstan and the average depth to the top of the aquifer is also 10m, while the average thickness of the aquifer system is 1 500m. The aquifer is mostly confined, but some parts are unconfined.

Hydrogeological aspects
While the Quaternary complex constitutes mainly sand, the Cretaceous and the Triassic-Jurassic complexes are mainly sandstone. All three aquifers have low primary porosity and no secondary porosity. Horizontal connectivity is low. No transmissivity data is available. The total volume of groundwater within has been estimated at 4 900 km³.

Linkages with other water systems
The predominant source of recharge is through precipitation on the aquifer area. The predominant groundwater discharge mechanism is through submarine outflow.

Environmental aspects
Over 99% of the TBA area natural groundwater quality DOES NOT satisfy local drinking water standards. TDS concentrations in the water vary over a wide range from 100 000 mg/l in areas with

AS35 - Amu-Darya

saline soils, to 300 – 800 mg/l in areas with barchan and ridge type sands of the Samsky Massif, overall averaging 25 000-35 000 mg/l. No pollution within the system has been detected.

Socio-economic aspects

Indications are that there is no significant abstraction from the aquifer because of the unsuitable water quality.

Legal and Institutional aspects

There are no Transboundary agreements between countries and no National Institutions with a mandate for groundwater management exists. However groundwater abstraction, groundwater quality protection, and drilling control are done according to law/ regulations, and measures are also applied in practice.

Emerging Issues

Because of the lack of usable groundwater, Transboundary groundwater issues cannot be foreseen.

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Considerations and recommendations

Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

Only one of the three aquifer states provided information and this was also not adequate to calculate groundwater indicators.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

Colophon

This Transboundary Aquifers information sheet has been produced as part of the Groundwater Component of the GEF Transboundary Water Assessment Programme (GEF TWAP). **GEF TWAP** is the first truly global comparative assessment of transboundary groundwater, lakes, rivers, large marine ecosystems and the open ocean. More information on TWAP can be found on: www.geftwap.org . **The Groundwater component** of TWAP carried out a global comparison of 199 transboundary aquifers and the groundwater systems of 41 Small Island Developing States. The data used to compile this transboundary aquifer information sheet has been made available by national and regional experts from countries involved in the TWAP Groundwater project. For aquifers larger than 20 000 km2 and which are not overlapping, additional data are available from modelling done by the Goethe University Frankfurt (Germany) as part of TWAP Groundwater. All data were compiled by UNESCO-IHP and the International Groundwater Resources Assessment Centre (IGRAC – UNESCO Category II Institute). Values given in the fact-sheet represent an approximate guide only and should not replace data obtained from recent local assessments. The editors of this information sheet are not responsible for the quality of the data.

For more information on TWAP Groundwater and for more data, please have a look at the TWAP Groundwater Information Management System which is accessible via www.twap.isarm.org or www.un-igrac.org.

AS35 - Amu-Darya

Request:
If you have additional data or information about this transboundary aquifer that can improve the quality of this information sheet and the underlying database, please contact us via email at info@un-igrac.org. If appropriate, the information will be uploaded to the database of transboundary aquifers and will also be used in new versions of this information sheet.

References:
- Population: Population has been calculated based on the aquifer map and grid information on population. Source population data: Center for International Earth Science Information Network - CIESIN - Columbia University, United Nations Food and Agriculture Programme - FAO, and Centro Internacional de Agricultura Tropical - CIAT. 2005. Gridded Population of the World, Version 3 (GPWv3): Population Count Grid, Future Estimates. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H42B8VZZ. Accessed Jan 2015.
- Rainfall: Average rainfall per TBA has been calculated based on the aquifer map and grid data for precipitation. Source precipitation data: Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. Grid data download from www.worldclim.org (2015): Data for current conditions (~1950-2000), ESRI grids, 30 arc seconds, Precipitation.
- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: May 2017

AS37 – Birata-Urgench

Geography

Total area TBA (km^2): 60 000

No. countries sharing: 2

Countries sharing: Uzbekistan, Turkmenistan

Population: 3 300 000

Climate Zone: Arid

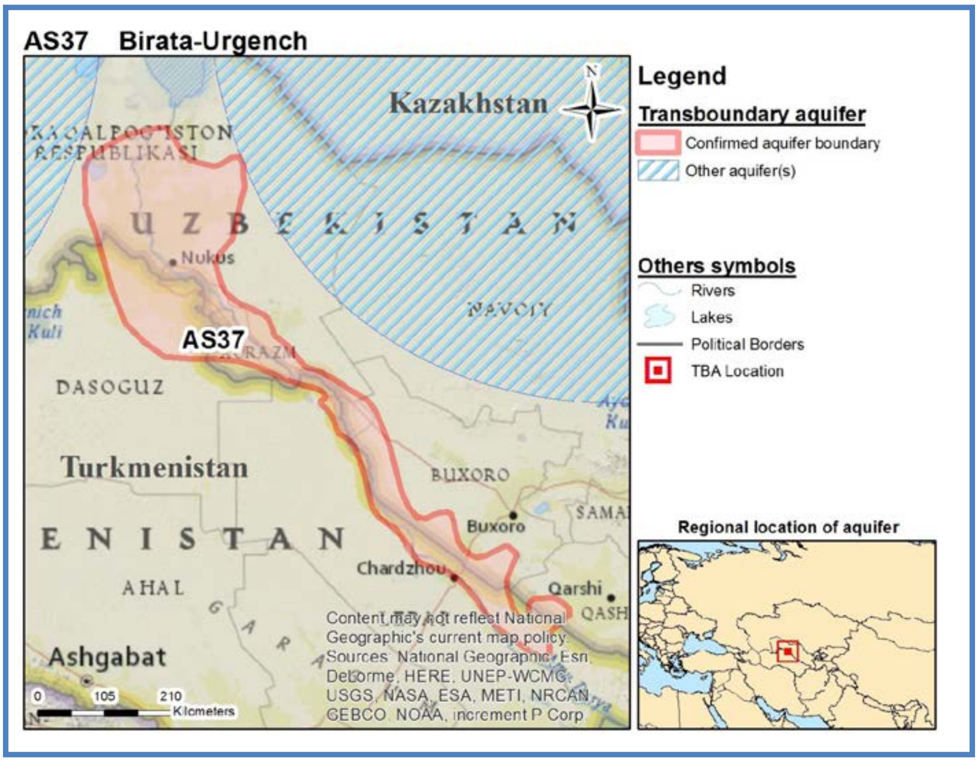
Rainfall (mm/yr): 120

Hydrogeology

Aquifer type: Multi-layered and hydraulically connected

Degree of confinement: Mostly confined

Main Lithology: Sediments – gravels, sands and loam



No cross-section available

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS37 – Birata-Urgench

TWAP Groundwater Indicators from Global Inventory

No data available.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
Turkmenistan	180	3500	-18	-27	3	55	2	23
Uzbekistan	140	2800	-19	-29	5	87	3	28
TBA level	**150**	**3000**	**-19**	**-28**	**4**	**77**	**3**	**24**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
Turkmenistan	0	51	29	48	7	1	1
Uzbekistan	0	48	31	51	11	2	3
TBA level	**0**	**49**	**30**	**50**	**9**	**1**	**2**

Key parameters table from Global Inventory

No data available.

Aquifer description

Aquifer geometry

The Birata-Urgench artesian basin belongs to the Amu-Darya Basin, which occupies a huge depression that is open to the Aral Sea. It is a multi 5-layered system that is mostly confined. In general, the artesian basin contains: Quaternary aquifers that overlie Paleogene and Neogene aquifers and confining beds; these overlie Cretaceous aquifers and confining beds; these in turn overlie Jurassic aquifers and confining beds; that overlie the Permian and Triassic aquifers and confining beds. Groundwater originates from aquifers that occur at depths ranging from 100m (in the upper reaches) to 1.5m (in the lower reaches). The thickness of the aquifer system is greater than 300 m in the center and decreases towards the margins.

Hydrogeological aspects

Quaternary deposits are most widespread in the central part of the Amu-Darya basin. Host rocks are sands of varying grain size with inter-beds of gravels, loams and sandy loams.

Linkages with other water systems

Groundwater is recharged by seepage from surface water sources, surface and subsurface runoff from mountain slopes, and rainfall infiltration in areas with barchan sands. The general direction of the groundwater flow is from ESE to WNW—from the rivers of Amu-Darya, Murgaba and Tedjneva

AS37 – Birata-Urgench

towards the Caspian Sea. Local discharge areas are often closed depressions (valleys) whose floors are covered by saline soils (solonchak soils).

Environmental aspects
The depth origin of the groundwater has a strong bearing on its TDS. TDS varies over a wide range from around 1000 to 50 000 mg/l. The chemical composition changes according to the TDS contents: bicarbonate and sulfate-bicarbonate, bicarbonate-sulfate-chloride, then sulfate-chloride, and finally chloride.

Socio-economic aspects
Human development on the aquifer is a function of groundwater levels and TDS concentrations in the water. For example, in irrigated (cultivated) areas the groundwater table occurs at depths of 0.5-3 m while in the virgin areas it goes down to 20-50 m below the surface.

Legal and Institutional aspects
No information was provided.

Emerging Issues
No serious issues are foreseen

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Dmitrii Plaksin		Kyrgyzstan	plaksind@ya.ru	Regional coordinator

Considerations and recommendations

None of the two TBA states provided data to the global inventory. The only tabular information that could be presented here has been derived from the global WaterGAP model, whereas the limited aquifer description is based on a summary in the Regional Report for Central Asia. See colophon for more information, including references to data from other sources.

Request:
If you have data or information about this transboundary aquifer that can improve the quality of this information sheet and the underlying database, please contact us via email at info@un-igrac.org. If appropriate, the information will be uploaded to the database of transboundary aquifers and will also be used in new versions of this information sheet.

Colophon

This Transboundary Aquifers information sheet has been produced as part of the Groundwater Component of the GEF Transboundary Water Assessment Programme (GEF TWAP). **GEF TWAP** is the first truly global comparative assessment of transboundary groundwater, lakes, rivers, large marine ecosystems and the open ocean. More information on TWAP can be found on: www.geftwap.org . **The Groundwater component** of TWAP carried out a global comparison of 199 transboundary aquifers and the groundwater systems of 41 Small Island Developing States. The data used to compile this transboundary aquifer information sheet has been made available by national and regional experts from countries involved in the TWAP Groundwater project. For aquifers larger than 20 000 km2 and which are not overlapping, additional data are available from modelling done by the Goethe University Frankfurt (Germany) as part of TWAP Groundwater. All data were compiled by UNESCO-IHP and the International Groundwater Resources Assessment Centre (IGRAC – UNESCO Category II Institute). Values given in the fact-sheet represent an approximate guide only and should not replace data obtained from recent local assessments. The editors of this information sheet are not responsible for the quality of the data.

For more information on TWAP Groundwater and for more data, please have a look at the TWAP Groundwater Information Management System which is accessible via www.twap.isarm.org or www.un-igrac.org.

AS37 – Birata-Urgench

References:

- Population: Population has been calculated based on the aquifer map and grid information on population. Source population data: Center for International Earth Science Information Network - CIESIN - Columbia University, United Nations Food and Agriculture Programme - FAO, and Centro Internacional de Agricultura Tropical - CIAT. 2005. Gridded Population of the World, Version 3 (GPWv3): Population Count Grid, Future Estimates. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H42B8VZZ. Accessed Jan 2015.
- Rainfall: Average rainfall per TBA has been calculated based on the aquifer map and grid data for precipitation. Source precipitation data: Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. Grid data download from www.worldclim.org (2015): Data for current conditions (~1950-2000), ESRI grids, 30 arc seconds, Precipitation.
- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: December 2015

AS108 - Buir Nuur-Khalkh River Aquifer

Geography

Total area TBA (km^2): 25 000
No. countries sharing: 2
Countries sharing: Mongolia, China
Population: 23 000
Climate Zone: Semi-arid
Rainfall (mm/yr): 300

Hydrogeology

Aquifer type: Multiple-layered hydraulically connected
Degree of confinement: Mostly unconfined, but some parts are confined
Main Lithology: Sediment – calcareous sand

No cross-section available

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS108 - Buir Nuur-Khalkh River Aquifer

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
China							2			
Mongolia	10	12000	95	100	0		1	<5	B	D
TBA level							**1**			

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).
(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.
(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).
(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.
(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).
(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
China	130	75 000	-5	1	55	61	51	80
Mongolia	100	93 000	-11	-14	44	76	40	80
TBA level	**100**	**91 000**	**-11**	**-13**	**44**	**74**	**40**	**80**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
China	2	2	6	0	<1	0	0
Mongolia	2	1	15	20	<1	0	0
TBA level	**2**	**1**	**13**	**16**	**<1**	**0**	**0**

AS108 - Buir Nuur-Khalkh River Aquifer

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
China								
Mongolia	27**	47**	78	Aquifer mostly unconfined, but some parts confined	Sediment - Sand	Low primary porosity intergranular porosity	Secondary porosity: Dissolution	100
TBA level								

* Including aquitards/aquicludes

** These values would need revision, since a groundwater table higher than depth to top of the aquifer is un-realistic for an unconfined aquifer, although in this case the existence of some confined parts might imply a groundwater table higher than depth to top in average.

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Aquifer description

As most of the information was provided by Mongolia, most of the values within this brief refer to the portion of the TBA within Mongolia.

Aquifer geometry

This aquifer is a multiple 2-layered hydraulically connected system. The aquifer mostly unconfined, but some parts are confined. The average depth to the water table is 27 m, and the average depth to the top of the aquifer is 47 m while the average thickness of the aquifer system is 78 m.

Hydrogeological aspects

The predominant aquifer lithology is sediment – calcareous sand that has a very low primary intergranular porosity with secondary porosity: dissolution. It furthermore has a low horizontal and vertical connectivity. The average transmissivity value is 100 m^2/d. The total groundwater volume is 0.20 km^3. The average recharge into the system is 218 Mm^3/yr and the aerial extent of the recharge area is over an area of 11 100 km^2 (see Appendix). According to the long-term trend of the water levels the system shows no indications of groundwater depletion.

Linkages with other water systems

The predominant source of recharge is through precipitation over the aquifer area. On Mongolia side the groundwater and river discharge into the Buir lake.

Environmental aspects

Within Mongolia 5% the natural quality of the water is not suitable for human consumption over a significant part of the aquifer and this is mainly due to elevated levels of nitrates. With regard to anthropogenic groundwater pollution some pollution has been identified/ suspected within the superficial layers but the data is not available to determine the percentage of the aquifer area that has been affected. Around 15% of the aquifer within Mongolia is characterised by shallow groundwater and 5% of the aquifer area is covered with groundwater dependent ecosystems (see Appendix).

Socio-economic aspects

A total amount of 0.79 Mm^3 of groundwater was abstracted from the system during 2010 within Mongolia. This represents the total amount of fresh water that was abstracted over the aquifer area.

AS108 - Buir Nuur-Khalkh River Aquifer

Legal and Institutional aspects

According to Mongolia a Bilateral Agreement with limited scope for TBA management has been signed by all parties but no Transboundary Institute has been established. The National institution is in place, but is not fully operational.

Emerging Issues

The Transboundary Agreement needs to be applied and joint monitoring work needs to be encouraged. Problems with the quality of surface water in the river could have an impact on groundwater.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Sangam Shresta	Asian Institute of Technology	Thailand	sangamshrestha@gmail.com	Regional coordinator
Batdemberel Bayanzul	Mongolian University of Science and Technology	Mongolia	bbatdemderel_0608@yahoo.com	Contributing national expert
Erdenetsetseg Altangerel	Mongolian University of Science and Technology	Mongolia	a_erka_5001@yahoo.com	Contributing national expert
Aley Mustafa	Mongolian University of Science and Technology	Mongolia	aleymstf@yahoo.com	Contributing national expert
Jadambaa Namjil	freelance expert	Mongolia	n_jadambaa@yahoo.com	Contributing national expert
Buyankhishig Nemer	Mongolian University of Science and Technology	Mongolia	bbn@must.edu.mn	Contributing national expert

Considerations and recommendations

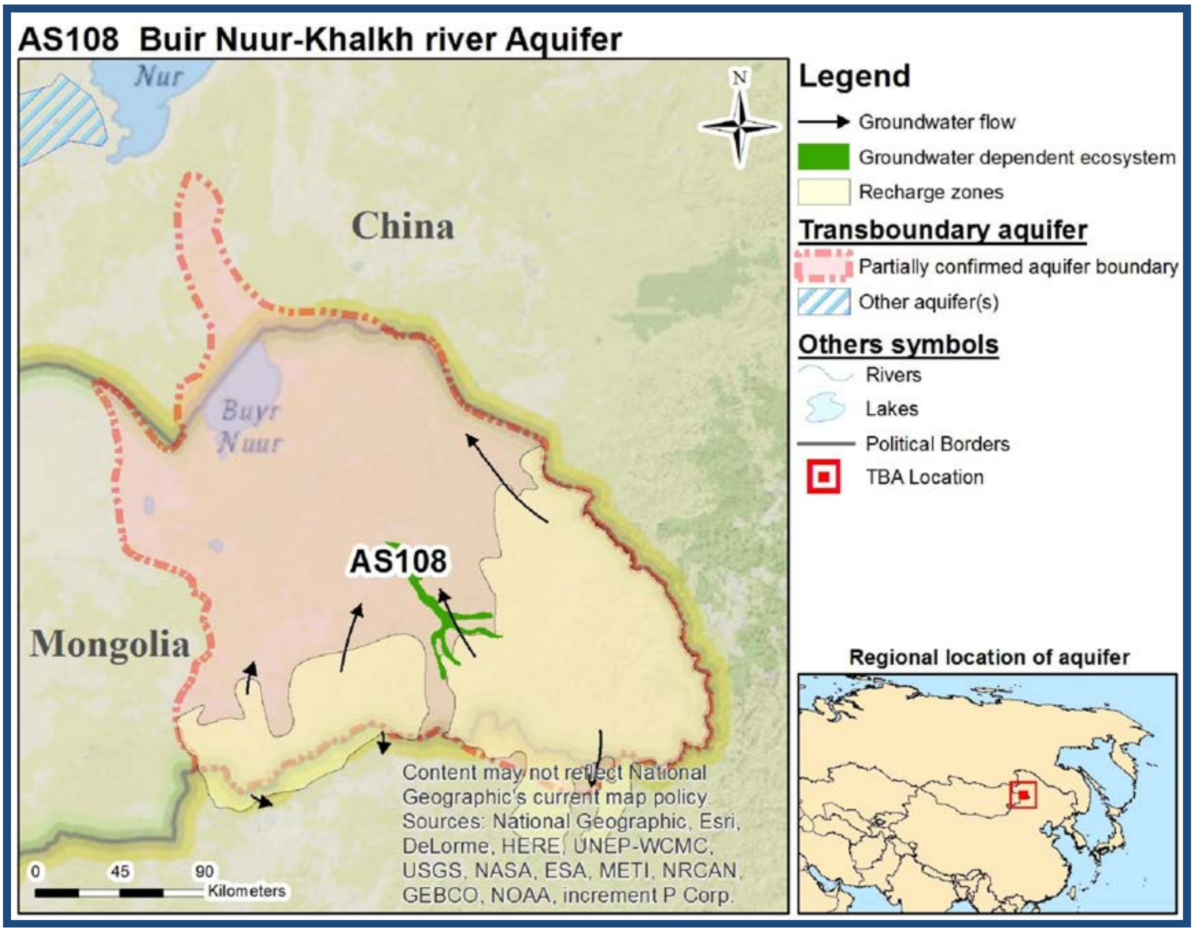
Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

One of the TBA countries contributed to the information. The information was adequate to describe the aquifer in general terms. Quantitative information was also available, and the indicators at the national level could also be calculated.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

AS108 - Buir Nuur-Khalkh River Aquifer

Appendix: AS108



Map showing the main recharge zones and groundwater dependent ecosystems within the Buir Nuur-Khalkh River Aquifer

Colophon

This Transboundary Aquifers information sheet has been produced as part of the Groundwater Component of the GEF Transboundary Water Assessment Programme (GEF TWAP). **GEF TWAP** is the first truly global comparative assessment of transboundary groundwater, lakes, rivers, large marine ecosystems and the open ocean. More information on TWAP can be found on: www.geftwap.org . **The Groundwater component** of TWAP carried out a global comparison of 199 transboundary aquifers and the groundwater systems of 41 Small Island Developing States. The data used to compile this transboundary aquifer information sheet has been made available by national and regional experts from countries involved in the TWAP Groundwater project. For aquifers larger than 20 000 km2 and which are not overlapping, additional data are available from modelling done by the Goethe University Frankfurt (Germany) as part of TWAP Groundwater. All data were compiled by UNESCO-IHP and the International Groundwater Resources Assessment Centre (IGRAC – UNESCO Category II Institute). Values given in the fact-sheet represent an approximate guide only and should not replace data obtained from recent local assessments. The editors of this information sheet are not responsible for the quality of the data.

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Request:
If you have additional data or information about this transboundary aquifer that can improve the quality of this information sheet and the underlying database, please contact us via email at info@un-igrac.org. If appropriate, the information will be uploaded to the database of transboundary aquifers and will also be used in new versions of this information sheet.

AS108 - Buir Nuur-Khalkh River Aquifer

References:

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- Rainfall: Average rainfall per TBA has been calculated based on the aquifer map and grid data for precipitation. Source precipitation data: Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. Grid data download from www.worldclim.org (2015): Data for current conditions (~1950-2000), ESRI grids, 30 arc seconds, Precipitation.
- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: December 2015

AS111 - Dankhan Khudgiin Sair Aquifer

Geography

Total area TBA (km^2): 24 000

No. countries sharing: 2

Countries sharing: Mongolia, China

Population: 9 000

Climate Zone: Arid

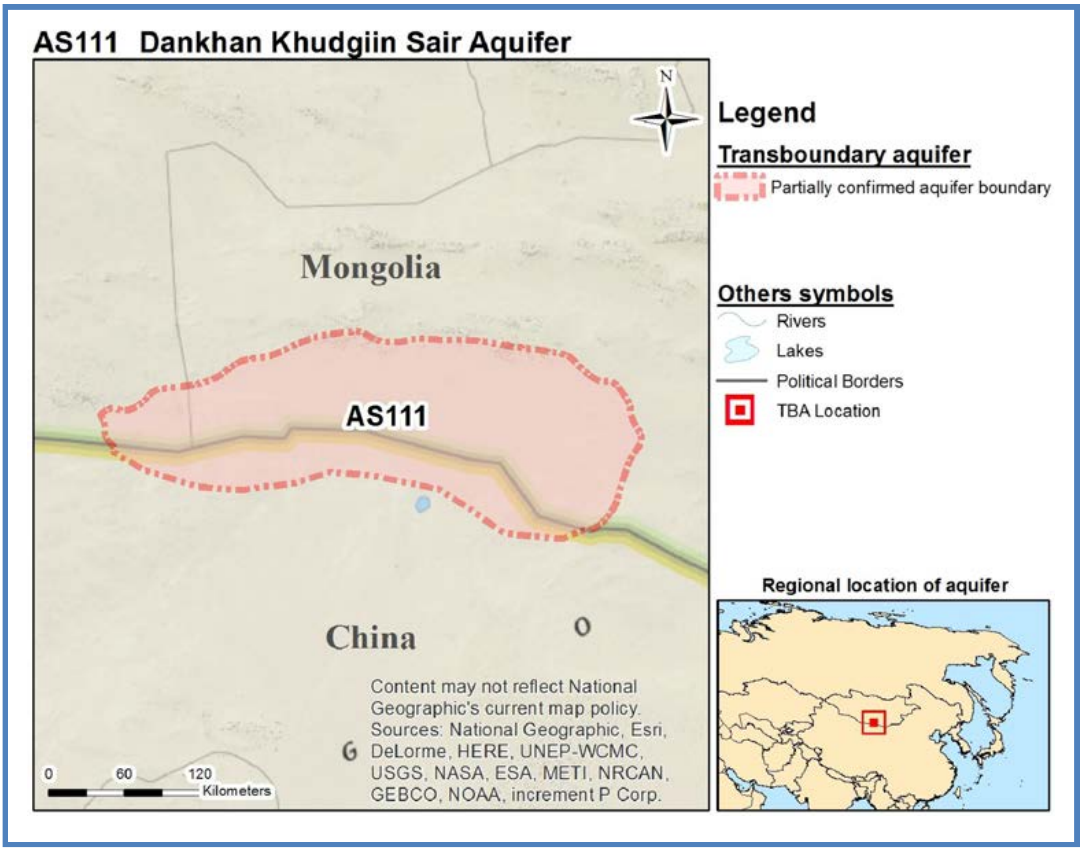
Rainfall (mm/yr): 60

Hydrogeology

Aquifer type: Multiple layers hydraulically connected

Degree of confinement: Mostly unconfined, but some parts confined

Main Lithology: Sediment - sand



No cross-section available

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS111 - Dankhan Khudgiin Sair Aquifer

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
China							<1			
Mongolia	10	26 000	100	100	0		<1	<5	B	D
TBA level							<1			

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).
(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.
(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).
(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.
(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).
(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
China	8	20000	-16	-21	50	64	50	0
Mongolia	1	3000	9	43	70	80	26	0
TBA level	**3**	**7600**	**-14**	**-23**	**51**	**75**	**49**	**0**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
China	0	<1	13	16	6	4	5
Mongolia	0	<1	25	43	1	1	1
TBA level	**0**	<1	**22**	**36**	**4**	**3**	**3**

AS111 - Dankhan Khudgiin Sair Aquifer

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
China								
Mongolia	20	26	42	Aquifer mostly unconfined, but some parts confined	Sediment - Sand	High primary porosity fine medium sedimentary deposits	Secondary porosity: Fractures	39
TBA level								

* Including aquitards/aquicludes
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Aquifer description

As most of the information was provided by Mongolia, most of the values within this brief refer to the portion of the TBA within Mongolia.

Aquifer geometry
This aquifer is a multiple 2-layered hydraulically connected system that is mostly unconfined, but some parts are confined. The average depth to the water table is 20 m, and the average depth to the top of the aquifer is 26 m while the average thickness of the aquifer system is 42 m.

Hydrogeological aspects
The predominant aquifer lithology is sediment - sand that has a high primary porosity with secondary porosity: fractures. It furthermore has a low horizontal and vertical connectivity. The average transmissivity value is 39 m^2/d. The total groundwater volume is 1.65 km^3. The average recharge into the system is 170 Mm^3/yr and the aerial extent of the recharge area is over 5700 km^2 (see Appendix). According to the long-term trend of the water levels the system shows no indications of groundwater depletion.

Linkages with other water systems
The predominant source of recharge is through precipitation over the aquifer area. No linkages were observed. The predominant discharge mechanism is through groundwater flow into another aquifer.

Environmental aspects
Within Mongolia the entire natural water within the aquifer is suitable for human consumption and no anthropogenic groundwater pollution has been identified. Within Mongolia 10% of the aquifer is characterised by shallow groundwater whereas no groundwater dependent ecosystems over the aquifer area were recorded.

Socio-economic aspects
A total amount of 0.61 Mm^3 of groundwater was abstracted from the system during 2010 within Mongolia and this represents the total amount of water that was utilised over the aquifer area within that country.

Legal and Institutional aspects

United Nations Educational, Scientific and Cultural Organization · International Hydrological Programme

AS111 - Dankhan Khudgiin Sair Aquifer

According to Mongolia a Bilateral Agreement with limited scope for TBA management has been signed by all parties but no Transboundary Institute has been established. The National institution is in place, but is not fully operational.

Emerging Issues

The Transboundary Agreement needs to be applied and joint monitoring work needs to be encouraged.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Sangam Shresta	Asian Institute of Technology	Thailand	sangamshrestha@gmail.com	Regional coordinator
Batdemberel Bayanzul	Mongolian University of Science and Technology	Mongolia	bbatdemderel_0608@yahoo.com	Contributing national expert
Erdenetsetseg Altangerel	Mongolian University of Science and Technology	Mongolia	a_erka_5001@yahoo.com	Contributing national expert
Aley Mustafa	Mongolian University of Science and Technology	Mongolia	aleymstf@yahoo.com	Contributing national expert
Jadambaa Namjil	freelance expert	Mongolia	n_jadambaa@yahoo.com	Contributing national expert
Buyankhishig Nemer	Mongolian University of Science and Technology	Mongolia	bbn@must.edu.mn	Contributing national expert

Considerations and recommendations

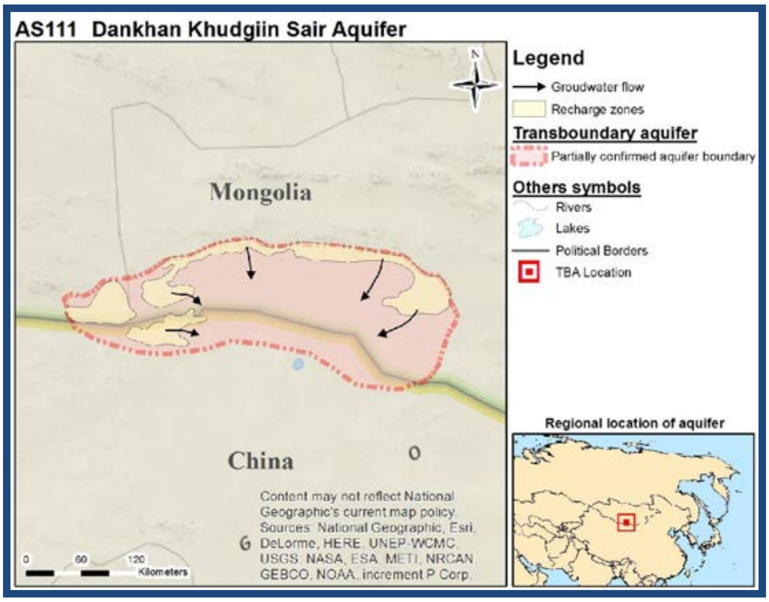
Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

One of the TBA countries contributed to the information. The information was adequate to describe the aquifer in general terms. Quantitative information was also available, and the indicators at the national level could also be calculated.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

AS111 - Dankhan Khudgiin Sair Aquifer

Appendix: AS111 –



Map showing the main Recharge zones within the Dankhan Khudgiin Sair Aquifer

Colophon

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For more information on TWAP Groundwater and for more data, please have a look at the TWAP Groundwater Information Management System which is accessible via www.twap.isarm.org or www.un-igrac.org.

Request:
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References:

- Population: Population has been calculated based on the aquifer map and grid information on population. Source population data: Center for International Earth Science Information Network - CIESIN - Columbia University, United Nations Food and Agriculture Programme - FAO, and Centro Internacional de Agricultura Tropical - CIAT. 2005. Gridded Population of the World, Version 3 (GPWv3): Population Count Grid, Future Estimates. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H42B8VZZ. Accessed Jan 2015.
- Rainfall: Average rainfall per TBA has been calculated based on the aquifer map and grid data for precipitation. Source precipitation data: Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. Grid data download from www.worldclim.org (2015): Data for current conditions (~1950-2000), ESRI grids, 30 arc seconds, Precipitation.
- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: October 2015

UNEP gef United Nations Educational, Scientific and Cultural Organization · International Hydrological Programme igrac International Groundwater Resources Assessment Centre

AS97 - Delger River

Geography

Total area TBA (km^2): 23 000

No. countries sharing: 2

Countries sharing: Mongolia, Russia

Population: 33 000

Climate Zone: Subarctic

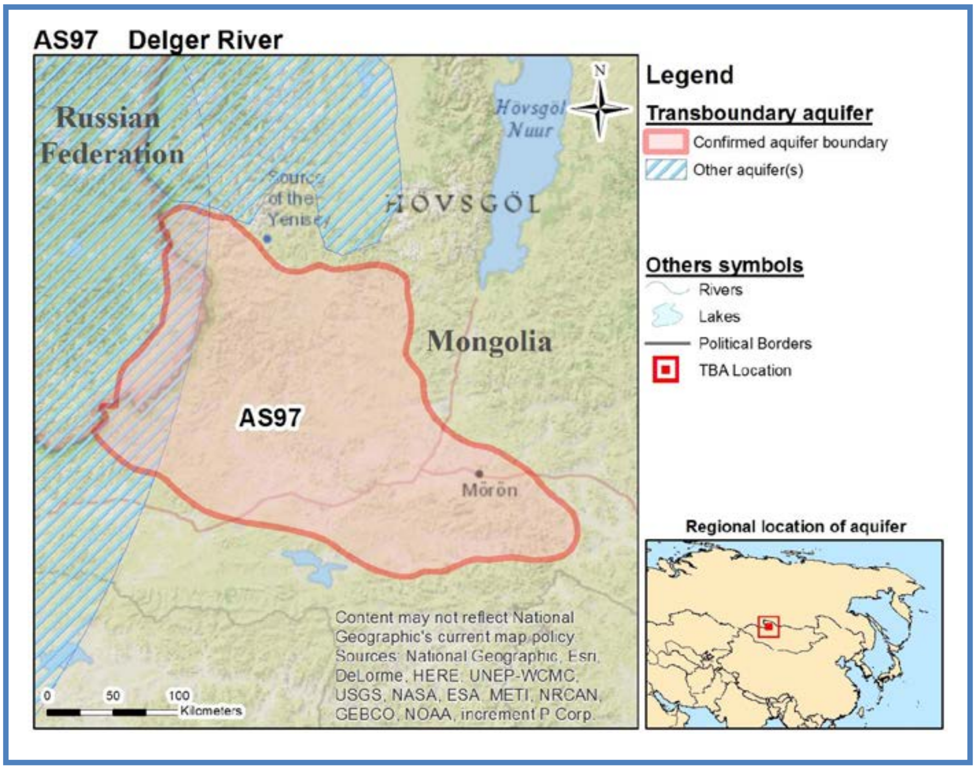
Rainfall (mm/yr): 280

Hydrogeology

Aquifer type: Multiple-layered hydraulically connected

Degree of confinement: Mostly unconfined, but some parts confined

Main Lithology: Data not available



No cross-section available

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS97 - Delger River

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
Mongolia	21	14000	100	100	0		2	<5	B	D
Russian Federation							1			
TBA level							**1**			

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).
(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.
(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).
(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.
(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).
(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
Mongolia	21	15 000	-21	-32	67	80	26	80
Russian Federation	2	2000	-2	-5	48	47	0	80
TBA level	**20**	**15 000**	**-20**	**-31**	**66**	**77**	**26**	**80**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
Mongolia	0	1	29	51	<1	0	1
Russian Federation	0	1	14	22	1	1	3
TBA level	**0**	**1**	**28**	**49**	**<1**	**0**	**1**

AS97 - Delger River

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
Mongolia	19**	50**	104	Aquifer mostly unconfined, but some parts confined		High primary porosity fine/ medium sedimentary deposits	Secondary porosity: fractures	500
Russian Federation								
TBA level								

* Including aquitards/aquicludes

** These values would need revision, since a groundwater table higher than depth to top of the aquifer is un-realistic for an unconfined aquifer, although in this case the existence of some confined parts might imply a groundwater table higher than depth to top as an average.

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Aquifer description

As most of the information was provided by Mongolia, most of the values within this brief refer to the portion of the TBA within Mongolia.

Aquifer geometry

This aquifer is a multiple-layered hydraulically connected system with 2 main layers. The Aquifer is mostly unconfined, but some parts are confined. The average depth to the water table is 19 m within Mongolia, and the average depth to the top of the aquifer is 50 m while the average thickness of the aquifer system is 104 m.

Hydrogeological aspects

Information is not available on the predominant aquifer lithology. It however is characterised by a low primary porosity with secondary porosity: fractures. It furthermore has a low horizontal and vertical connectivity. The average transmissivity value is 500 m^2/d. The average recharge into the system is 435 Mm^3/yr and the aerial extent of the major recharge area is 18 900 km^2 (see appendix).

Linkages with other water systems

The predominant source of recharge is through precipitation over the aquifer area. The predominant discharge mechanism is through outflow into lakes.

Environmental aspects

None of the natural water quality is unfit for human consumption and furthermore no anthropogenic groundwater pollution has been identified. Around 29% of the aquifer within Mongolia is characterised by shallow groundwater whereas 27% of the aquifer area is covered with groundwater dependent ecosystems.

Socio-economic aspects

A total amount of 0.16 Mm^3 of groundwater was abstracted from the system during 2010 within Mongolia. The total amount of fresh water abstraction over the aquifer area was 4.50 Mm^3.

AS97 - Delger River

Legal and Institutional aspects
According to Mongolia a Bilateral Agreement with limited scope for TBA management has been signed by all parties but no Transboundary Institute has been established. The National institution is in place, but is not fully operational.

Emerging Issues
The total amount of stored groundwater and the recharge into the system needs to be reviewed.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Sangam Shresta	Asian Institute of Technology	Thailand	sangamshrestha@gmail.com	Regional coordinator
Lucila Candela	Universidad Politécnica de Catalunya	Spain	Lucila.Candela@upc.edu	Regional coordinator
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Aley Mustafa	Mongolian University of Science and Technology	Mongolia	aleymstf@yahoo.com	Contributing national expert
Jadambaa Namjil	freelance expert	Mongolia	n_jadambaa@yahoo.com	Contributing national expert
Buyankhishig Nemer	Mongolian University of Science and Technology	Mongolia	bbn@must.edu.mn	Contributing national expert

Considerations and recommendations

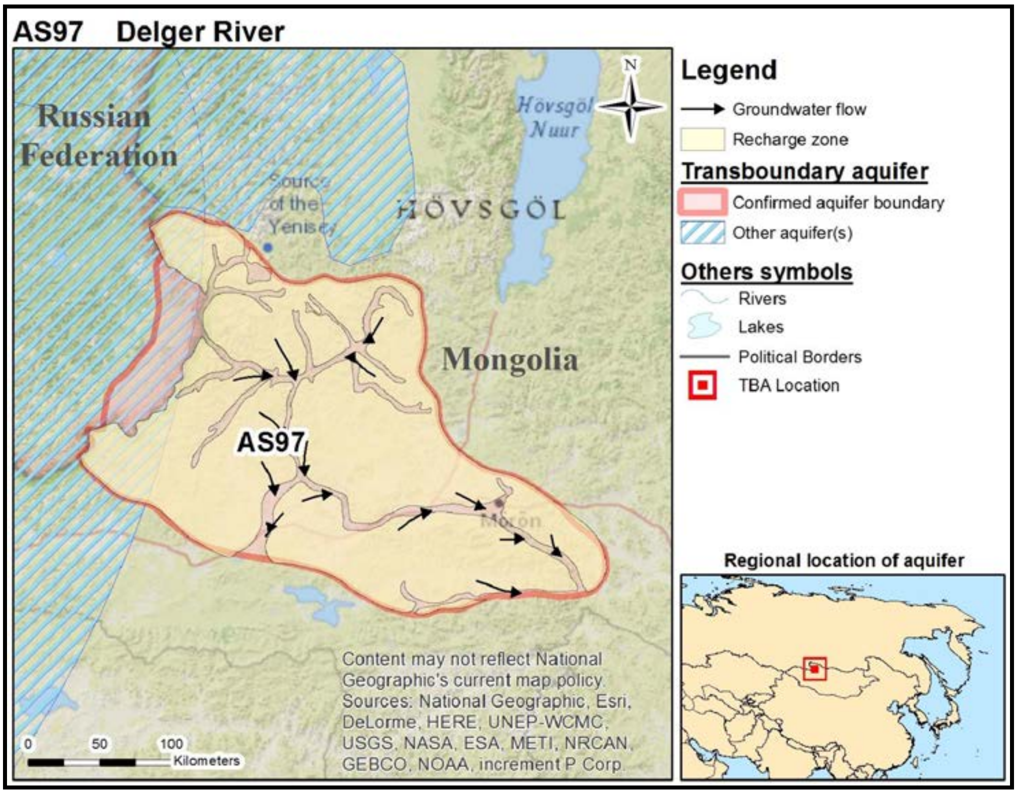
Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

One of the TBA countries contributed to the information. The information was adequate to describe the aquifer in general terms. Quantitative information was also available, and the indicators at the national level could also be calculated. The total groundwater volume within Mongolia needs to be reviewed.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

AS97 - Delger River

Appendix: AS97



TBA Map Showing Recharge Zones within the Delger River TBA

Colophon

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For more information on TWAP Groundwater and for more data, please have a look at the TWAP Groundwater Information Management System which is accessible via www.twap.isarm.org or www.un-igrac.org.

Request:

If you have additional data or information about this transboundary aquifer that can improve the quality of this information sheet and the underlying database, please contact us via email at info@un-igrac.org. If appropriate, the information will be uploaded to the database of transboundary aquifers and will also be used in new versions of this information sheet.

References:

- Population: Population has been calculated based on the aquifer map and grid information on population. Source population data: Center for International Earth Science Information Network - CIESIN - Columbia University, United Nations Food and Agriculture Programme - FAO, and Centro Internacional de Agricultura Tropical - CIAT. 2005. Gridded Population of the World, Version 3 (GPWv3): Population Count Grid, Future Estimates. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H42B8VZZ. Accessed Jan 2015.

AS97 - Delger River

- Rainfall: Average rainfall per TBA has been calculated based on the aquifer map and grid data for precipitation. Source precipitation data: Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. Grid data download from www.worldclim.org (2015): Data for current conditions (~1950-2000), ESRI grids, 30 arc seconds, Precipitation.
- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: December 2015

AS93 - Downstream of Lancang River

Geography

Total area TBA (km^2): 40 000

No. countries sharing: 2

Countries sharing: China, Myanmar

Population: 2 400 000

Climate Zone: Humid Subtropical

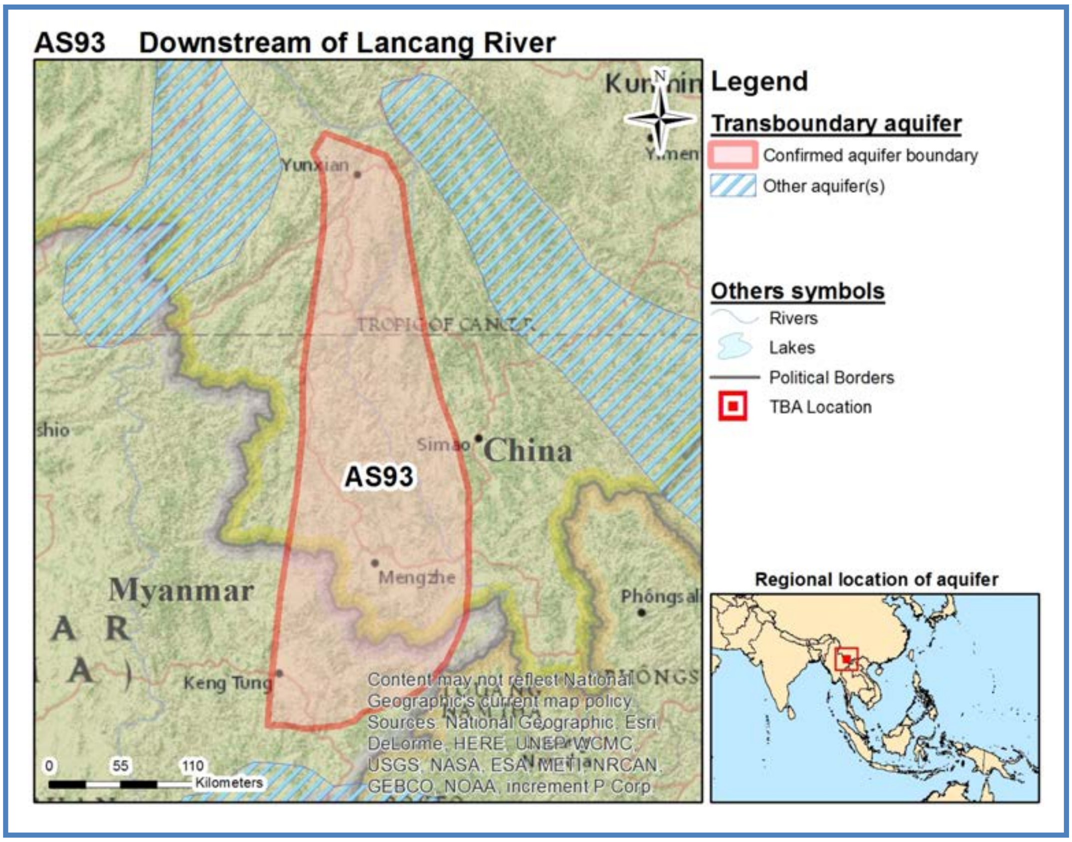
Rainfall (mm/yr): 1400

Hydrogeology

Aquifer type: Single-layered system

Degree of confinement: Semi-confined

Main Lithology: Sediment –sand



No Cross-section Provided

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS93 - Downstream of Lancang River

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
China	<1	<1	100	40	700		70	>1000	A	A
Myanmar							28			
TBA level							**60**			

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).

(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.

(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).

(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.

(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).

(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
China	160	2200	-8	6	1	4	0	0
Myanmar	150	5900	-19	-17	6	16	1	0
TBA level	**160**	**2600**	**-9**	**3**	**1**	**5**	**0**	**0**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
China	0	70	3	-6	<1	0	0
Myanmar	-1	25	15	18	<1	0	0
TBA level	**0**	**60**	**4**	**-4**	<1	**0**	**0**

AS93 - Downstream of Lancang River

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
China	10	<5	180	Whole aquifer semi-confined	Sediment - Sand	High primary porosity fine/ medium sedimentary deposits	Secondary porosity: Fractures	3500
Myanmar								
TBA level								

* Including aquitards/aquicludes

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Aquifer description

As most of the information was provided by China, most of the values within this brief refer to the portion of the TBA within China.

Aquifer geometry

This aquifer is a single-layered system. The average depth to the water table is 10 m, and the average depth to the top of the aquifer is <5 m while the average thickness of the aquifer system is 180 m. The entire aquifer is semi-confined.

Hydrogeological aspects

The predominant aquifer lithology is sediment –sand that has a high primary porosity with secondary porosity: fractures. It furthermore has a high horizontal and vertical connectivity. The average transmissivity value is 3500 m^2/d. The total groundwater volume is 160 km^3. The average recharge into the system is 94 Mm^3/yr and the aerial extent of the major recharge area is over 26 000km^2.

Linkages with other water systems

The predominant source of recharge is through precipitation over the aquifer area. The predominant discharge mechanism within China is through river base flow.

Environmental aspects

Within China the natural groundwater quality of the aquifer is suitable for human consumption and only superficial amounts of natural salinity are found but this is only over small areas. Besides minor amounts within the superficial layers being affected by landfills and waste disposal sites, no further anthropogenic groundwater pollution has been identified. Around 20 % of the aquifer within China is characterised by shallow groundwater whereas 80 % of the aquifer area is covered with groundwater dependent ecosystems.

Socio-economic aspects

A total amount of 2 Mm^3 of groundwater was abstracted from the system during 2010 within China. The total amount of fresh water that was abstracted over the aquifer area within China for the same year was 10 Mm^3.

Legal and Institutional aspects

According to China a Full Scope signed Transboundary Agreement does exist and a Transboundary Institute with a Full Mandate and capacity is present.

AS93 - Downstream of Lancang River

Emerging Issues
No issues were identified.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Sangam Shresta	Asian Institute of Technology	Thailand	sangamshrestha@gmail.com	Regional coordinator
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Zaisheng Han	China University of Gesciences, Bejing	China	hanzsh@hotmail.com	Lead National Expert

Considerations and recommendations

Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

One of the 2 TBA countries contributed to the information. Information was adequate to describe the aquifer in general terms. Quantitative information was also available, and sufficient to calculate indicators at the national level.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

Colophon

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- Rainfall: Average rainfall per TBA has been calculated based on the aquifer map and grid data for precipitation. Source precipitation data: Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. Grid data download from www.worldclim.org (2015): Data for current conditions (~1950-2000), ESRI grids, 30 arc seconds, Precipitation.
- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: May 2017

AS76 – Ertix River

Geography

Total area TBA (km^2): 47 000

No. countries sharing: 2

Countries sharing: Kazakhstan, China

Population: 220 000

Climate Zone: Semi-arid

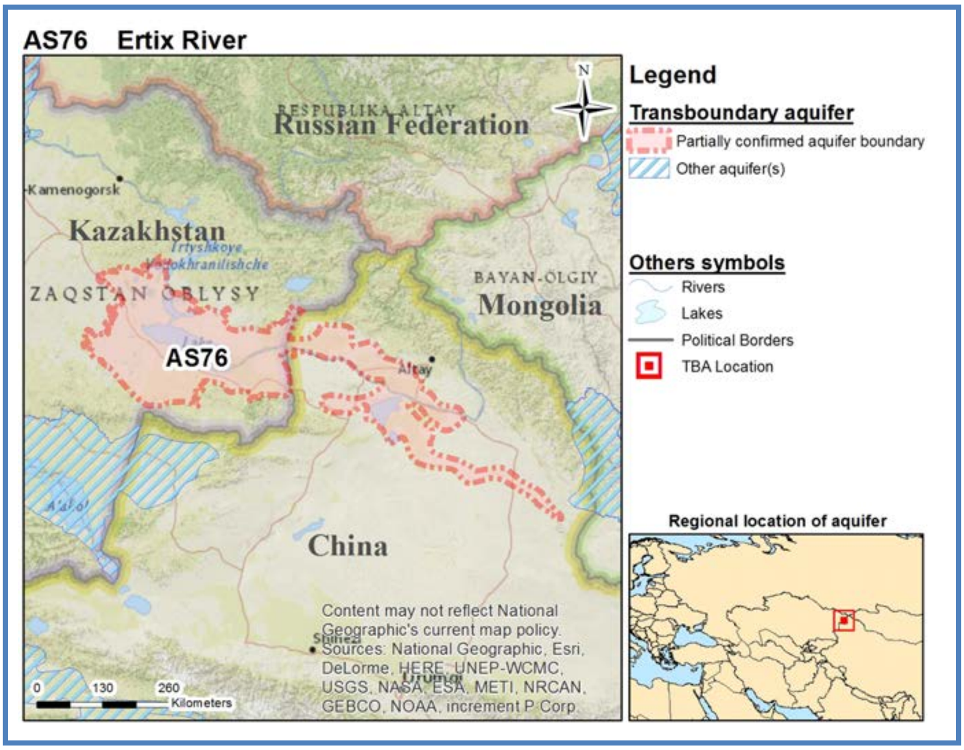
Rainfall (mm/yr): 250

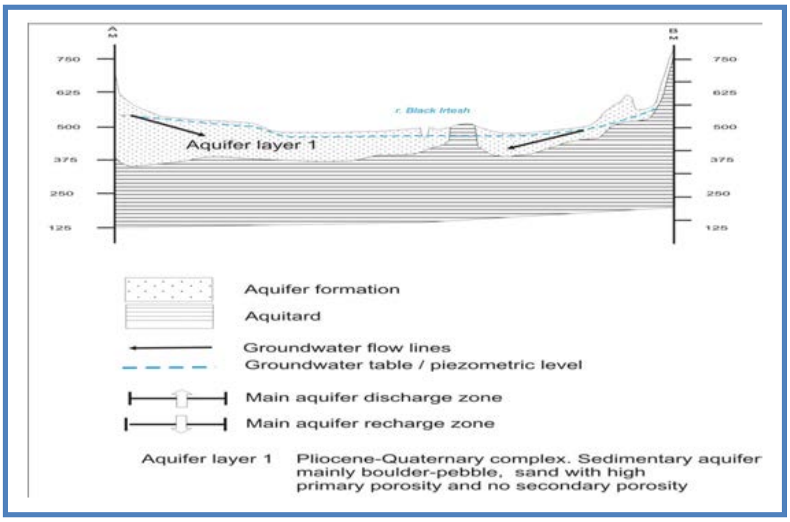
Hydrogeology

Aquifer type: Single to multi-layered system

Degree of confinement: Mostly confined, but some parts unconfined

Main Lithology: Sediment – sand and gravel





Geological cross-section along part of the Ertix River

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS76 – Ertix River

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
China	<1	<1	100	50	1200	A	7	<1000	A	A
Kazakhstan	38	11000			0		3	<5	D	E
TBA level	**24**	**5300**					**5**	**<5**	**E**	**F**

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).
(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.
(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).
(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.
(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).
(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
China	122	20 000	4	18	11	12	11	0
Kazakhstan	27	7600	-2	-5	4	36	4	37
TBA level	**62**	**14 000**	**-1**	**3**	**9**	**29**	**9**	**37**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
China	0	6	3	-6	9	0	0
Kazakhstan	0	4	17	27	5	0	0
TBA level	**0**	**5**	**10**	**11**	**8**	**0**	**0**

AS76 – Ertix River

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
China	15	<5	220	Aquifer Mostly confined, but some parts unconfined	Sediment - Sand	High Primary porosity fine/ medium sedimentary deposits	Secondary porosity: Dissolution	6000
Kazakhstan	<5	<5	290	Aquifer Mostly unconfined, but some parts confined	Sediment - Gravel	High Primary porosity fine/ medium sedimentary deposits	No Secondary porosity	1700
TBA level								

* Including aquitards/aquicludes
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Aquifer description

Aquifer geometry

This is a single to multi-layered system that varies from unconfined to confined conditions within Kazakhstan and China respectively. The average depth to the water table varies from 3m to 10m. The average depth to the top of the aquifer top of the aquifer is 3m while the average thickness of the aquifer system varies from 220m to 290m. Within Kazakhstan this is referred to as the Zaisan artesian basin and sometimes as the Irtysh river valley.

Hydrogeological aspects

The predominant aquifer lithology is sediment – sand and gravel that has a high primary porosity with some areas having no secondary porosity while the part within China does have secondary porosity: fractures. The formation is characterised by a high horizontal and vertical connectivity. The average transmissivity values are high and range from 1 730m^2/day to 6 000m^2/day. The total groundwater volume within the system is 90km^3. The average recharge into the system, that is 100% through natural recharge, is 1 100Mm^3/annum and the aerial extent of the major recharge area is 20 000km^2. Within China there is an annual amount of groundwater depletion of 2 km^3 that is probably due to over-pumping.

Linkages with other water systems

The predominant source of recharge is through infiltration from surface water bodies within Kazakhstan and through precipitation over the aquifer area within China. The major discharge mechanisms are through outflow into lakes within Kazakhstan and through river base flow within China (see Appendix).

Environmental aspects

Besides some natural salinity over parts of the superficial layers no other significant portion of the aquifer is unsuitable for human consumption. No major anthropogenic groundwater pollution has been identified. 20% of the aquifer within Kazakhstan is characterised by shallow groundwater

AS76 – Ertix River

whereas 80% of the TBA part within China has reported to be covered with groundwater dependent ecosystems.

Socio-economic aspects

A total of 3.14Mm^3 of water was abstracted from the system during 2010. A total amount of 2Mm^3 of fresh water was abstracted over the aquifer area within China for the same year. Within China there is an annual amount of groundwater depletion of 2 km3 that is probably due to over-pumping.

Legal and Institutional aspects

China reports signed Bilateral Agreement with full scope, while no Agreement is in place within Kazakhstan. A Transboundary Institute with a full mandate and capacity exists within China. No National Institute with a mandate currently exists within Kazakhstan although groundwater abstraction is controlled through law/ regulations and measures are also applied in practice. Within China the appropriate law/ regulations for groundwater abstraction are in preparation. With regard to groundwater quality and drilling control this is done according to law/ regulations and measures are also applied in practice.

Emerging Issues

Assistance within Kazakhstan is needed to establish a formal Institution and to prepare a Bilateral Agreement with the appropriate capacity for Transboundary Groundwater Management to be effective.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
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Jing He	China University of Gesciences, Bejing	China	hejing121486@126.com	Contributing national expert
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Zaisheng Han	China University of Gesciences, Bejing	China	hanzsh@hotmail.com	Lead National Expert
Aleksandr Kuchin	Hydrogeological research and design company "KazHYDEC" Ltd.	Kazakhstan	agkuchin@gmail.com	Contributing national expert
Oleg Podolny	Hydrogeological research and design company "KazHYDEC" Ltd.	Kazakhstan	podolnyo@mail.ru	Lead National Expert

Considerations and recommendations

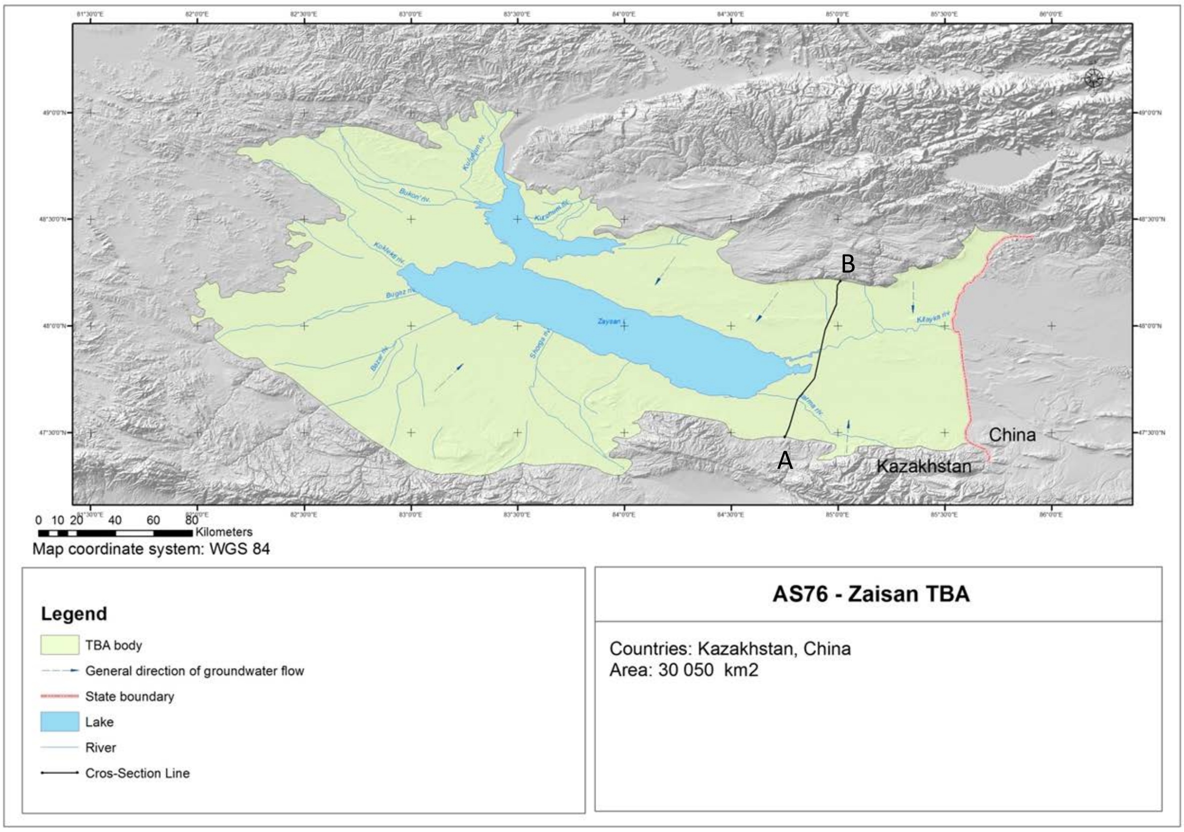
Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

Both aquifer states provided information, allowing for a good description of the aquifer and the calculation of transboundary groundwater indicators.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

AS76 – Ertix River

Appendix: AS76



Ertix River: Groundwater recharge and discharge regime, and location of cross section on page 1 (Kazachstan country segment only; known as Zaysan transboundary aquifer)

Colophon

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AS76 – Ertix River

References:

- Population: Population has been calculated based on the aquifer map and grid information on population. Source population data: Center for International Earth Science Information Network - CIESIN - Columbia University, United Nations Food and Agriculture Programme - FAO, and Centro Internacional de Agricultura Tropical - CIAT. 2005. Gridded Population of the World, Version 3 (GPWv3): Population Count Grid, Future Estimates. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H42B8VZZ. Accessed Jan 2015.
- Rainfall: Average rainfall per TBA has been calculated based on the aquifer map and grid data for precipitation. Source precipitation data: Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. Grid data download from www.worldclim.org (2015): Data for current conditions (~1950-2000), ESRI grids, 30 arc seconds, Precipitation.
- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: May 2017

AS92 - Hong River Basin

Geography

Total area TBA (km^2): 61 000

No. countries sharing: 3

Countries sharing: China, Lao People's Democratic Republic, Viet Nam

Population: 4 600 000

Climate Zone: Humid Subtropical

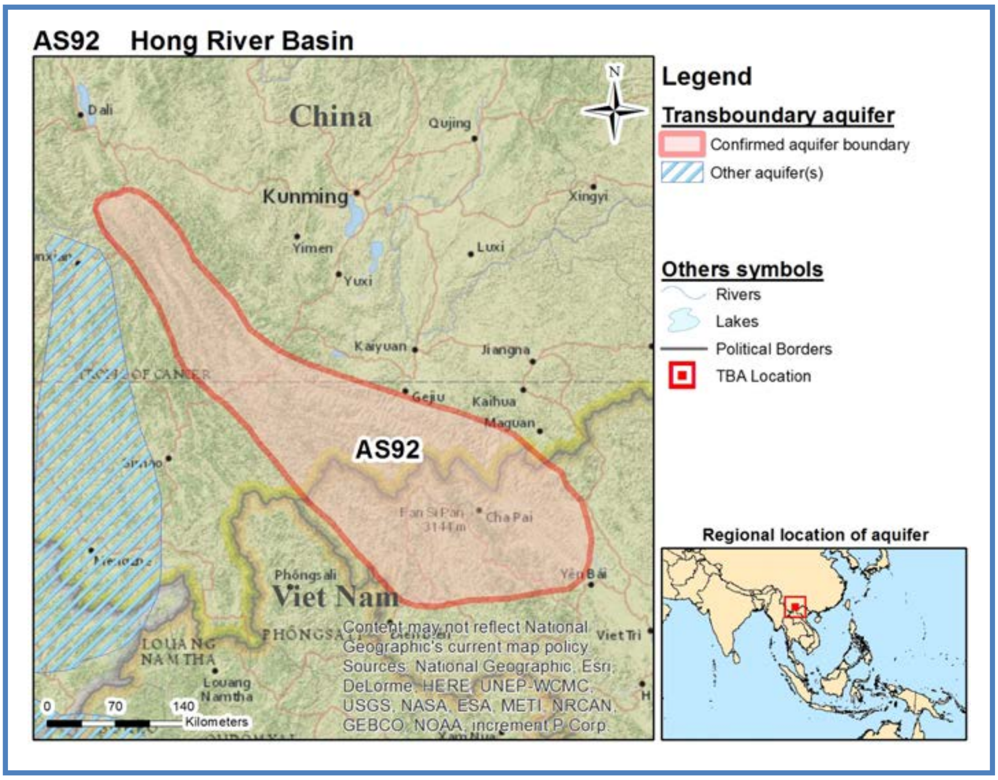
Rainfall (mm/yr): 1500

Hydrogeology

Aquifer type: Multiple-layered hydraulically connected

Degree of confinement: Whole aquifer unconfined

Main Lithology Sediment - sand



No Cross-section provided

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS92 - Hong River Basin

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
China	<1	<1	100	60	900		86	>1000	A	A
Lao People's Democratic Republic							12			
Viet Nam							63			
TBA level							**75**			

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).
(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.
(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).
(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.
(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).
(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
China	130	1400	-11	2	1	4	0	0
Laos	250	18 000	-30	-38	1	3	1	0
Viet Nam	200	3000	-24	-26	2	3	0	0
TBA level	**160**	**2000**	**-17**	**-11**	**1**	**3**	**0**	**0**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
China	1	88	4	-5	<1	0	0
Laos	1	14	29	46	<1	0	0
Viet Nam	0	67	18	23	<1	0	0

AS92 - Hong River Basin

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
TBA level	**0**	**78**	**9**	**6**	**<1**	**0**	**0**

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
China	10	<5	200	Whole aquifer unconfined	Sediment - Sand	High primary porosity fine/ medium sedimentary deposits	Secondary porosity: Fractures	4000
Lao People's Democratic Republic								
Viet Nam								
TBA level								

* Including aquitards/aquicludes

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Aquifer description

As most of the information was provided by China, most of the values within this brief refer to the portion of the TBA within China.

Aquifer geometry

This aquifer is a multiple-layered hydraulically connected system and the whole aquifer is unconfined. The average depth to the water table is 10 m, and the average depth to the top of the aquifer is <5 m while the average thickness of the aquifer system is 200 m.

Hydrogeological aspects

The predominant aquifer lithology is sediment –sand that has a high primary porosity with secondary porosity: fractures. It furthermore has a high horizontal and vertical connectivity. The average transmissivity value is 4000 m^2/d. The total groundwater volume is 160 km^3. The average recharge into the system is 100 Mm^3/yr and the aerial extent of the major recharge area is over 20 000 km^2.

Linkages with other water systems

The predominant source of recharge is through precipitation over the aquifer area. The predominant discharge mechanism within China is through river base flow.

Environmental aspects

AS92 - Hong River Basin

Within China the natural water quality of the aquifer is generally suitable for human consumption over the entire aquifer and only superficial amounts of natural salinity and fluoride are found but this is only over small areas. With regard to anthropogenic groundwater pollution besides minor amounts within the superficial layers being affected by landfills and waste disposal sites, no further groundwater pollution has been identified. Around 20% of the aquifer within China is characterised by shallow groundwater whereas 80% of the aquifer area is covered with groundwater dependent ecosystems.

Socio-economic aspects

A total amount of 3 Mm^3 of groundwater was abstracted from the system during 2010 within China. The total amount of fresh water that was abstracted over the aquifer area for the same year was 5 Mm^3.

Legal and Institutional aspects

According to China Full Scope signed Transboundary Agreement does exist and a Transboundary Institute with a full Mandate and capacity is present.

Emerging Issues

No issues were identified.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Sangam Shresta	Asian Institute of Technology	Thailand	sangamshrestha@gmail.com	Regional coordinator
Yao Li	China University of Gesciences, Bejing	China	ly2752@163.com	Contributing national expert
Jing He	China University of Gesciences, Bejing	China	hejing121486@126.com	Contributing national expert
Liyan Yue	China University of Gesciences, Bejing	China	yueliyan00120@126.com	Contributing national expert
Zaisheng Han	China University of Gesciences, Bejing	China	hanzsh@hotmail.com	Lead National Expert

Considerations and recommendations

Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

One of the 3 TBA countries contributed to the information. Information was adequate to describe the aquifer in general terms. Quantitative information was also available, and this was sufficient to calculate the indicators at the national level.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

Colophon

This Transboundary Aquifers information sheet has been produced as part of the Groundwater Component of the GEF Transboundary Water Assessment Programme (GEF TWAP). **GEF TWAP** is the first truly global comparative assessment of transboundary groundwater, lakes, rivers, large marine ecosystems and the open ocean. More information on TWAP can be found on: www.geftwap.org . **The Groundwater component** of TWAP carried out a global comparison of 199 transboundary aquifers and the groundwater systems of 41 Small Island Developing States. The data used to compile this transboundary aquifer information sheet has been made available by national and regional experts from countries involved in the TWAP Groundwater project. For aquifers larger than 20 000 km2 and which are not overlapping, additional data are available from modelling done by the Goethe University Frankfurt (Germany) as part of TWAP Groundwater. All data were compiled by

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UNESCO-IHP and the International Groundwater Resources Assessment Centre (IGRAC – UNESCO Category II Institute). Values given in the fact-sheet represent an approximate guide only and should not replace data obtained from recent local assessments. The editors of this information sheet are not responsible for the quality of the data.

For more information on TWAP Groundwater and for more data, please have a look at the TWAP Groundwater Information Management System which is accessible via www.twap.isarm.org or www.un-igrac.org.

Request:
If you have additional data or information about this transboundary aquifer that can improve the quality of this information sheet and the underlying database, please contact us via email at info@un-igrac.org. If appropriate, the information will be uploaded to the database of transboundary aquifers and will also be used in new versions of this information sheet.

References:

- Population: Population has been calculated based on the aquifer map and grid information on population. Source population data: Center for International Earth Science Information Network - CIESIN - Columbia University, United Nations Food and Agriculture Programme - FAO, and Centro Internacional de Agricultura Tropical - CIAT. 2005. Gridded Population of the World, Version 3 (GPWv3): Population Count Grid, Future Estimates. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H42B8VZZ. Accessed Jan 2015.
- Rainfall: Average rainfall per TBA has been calculated based on the aquifer map and grid data for precipitation. Source precipitation data: Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. Grid data download from www.worldclim.org (2015): Data for current conditions (~1950-2000), ESRI grids, 30 arc seconds, Precipitation.
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- All other data: TWAP Groundwater (2015).

Version: May 2017

AS72 - Ili River

Geography

Total area TBA (km^2): 32 000

No. countries sharing: 2

Countries sharing: China, Kazakhstan

Population: 1 100 000

Climate Zone: Highlands

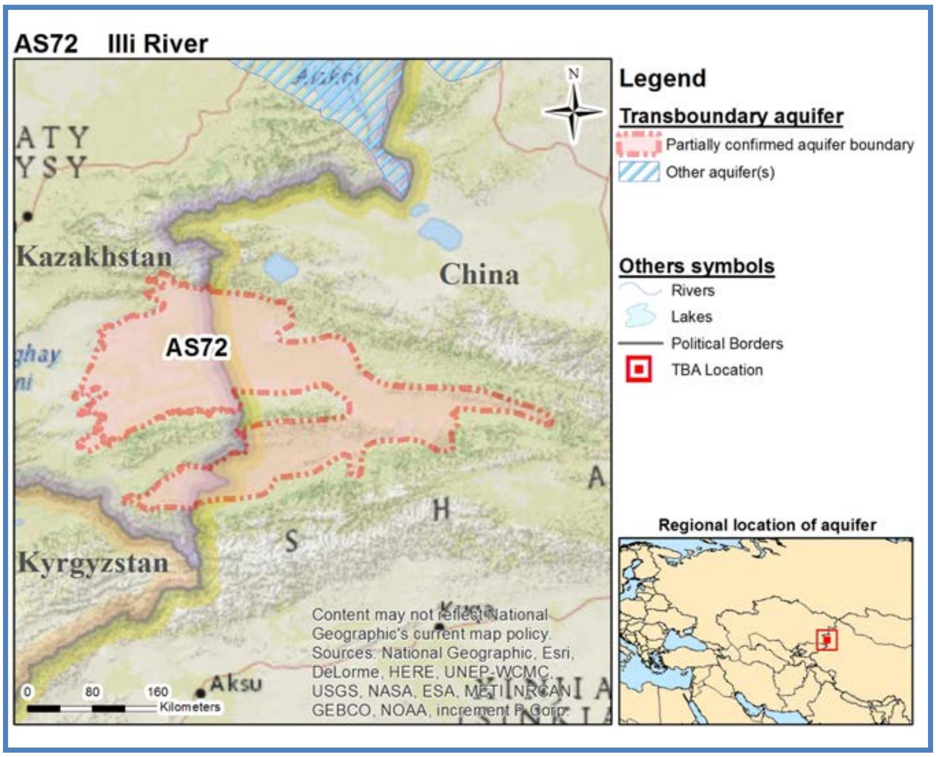
Rainfall (mm/yr): 320

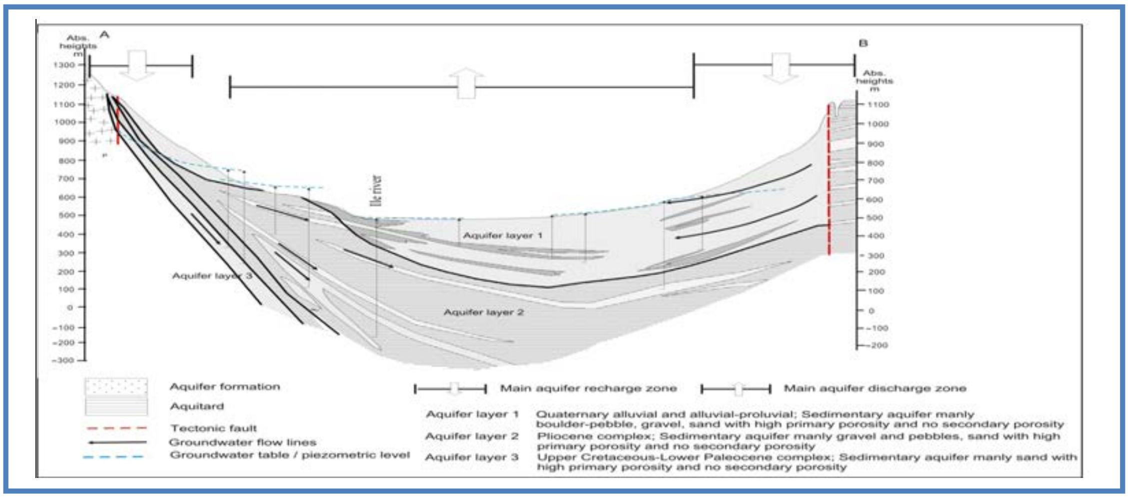
Hydrogeology

Aquifer type: Single layered to multi-layered

Degree of confinement: Unconfined to confined

Main Lithology: Sediment – sand and gravel





Geological Cross-section of the Ili River Transboundary Aquifer

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS72 - Ili River

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
China S1	<1	1	100	5	1000	A	48	15	A	A
Kazakhstan S2	280	36 000	100		0		8	<5	D	E
Kazakhstan S3	110	12 000			0		10	<5	F	E
TBA level	**55**	**1700**			**12 000 000 000**		**34**	<5	**E**	**F**

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).
(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.
(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).
(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.
(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).
(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
China	120	2600	5	22	11	12	11	23
Kazakhstan	46	4400	-8	-12	7	36	6	37
TBA level	**87**	**2900**	**3**	**15**	**11**	**19**	**11**	**34**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
China	0	44	3	-6	20	0	0

UNEP gef United Nations Educational, Scientific and Cultural Organization International Hydrological Programme igrac International Groundwater Resources Assessment Centre

AS72 - Ili River

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
Kazakhstan	0	10	15	23	7	1	1
TBA level	**0**	**30**	**5**	**-2**	**17**	**0**	**1**

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
China S1	10	<5	200	Aquifer mostly unconfined, but some parts confined	Sediment - Sand	High primary porosity fine/ medium sedimentary deposits	Secondary porosity: Fractures	4000
Kazakhstan S2	15	15	200	Whole Aquifer unconfined	Sediment - Gravel	Very high Primary porosity gravels/ pebbles	No Secondary porosity	1200
Kazakhstan S3	8	8	1000	Aquifer Mostly confined, but some parts unconfined	Sediment - Gravel	High Primary porosity fine/ medium sedimentary deposits	No Secondary porosity	4100
TBA level								

* Including aquitards/aquicludes
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Aquifer description

Due to its special geometry, the Ili aquifer is considered as two different aquifers in Kazakhstan and only as one in China. Accordingly, all of the information on Ili aquifer it has been classified by layers (S1, S2 and S3). The indicators at TBA level are therefore difficult to calculate.

Aquifer geometry
The upper aquifer (layer 1) is a single-layered system that is mostly unconfined, but some parts are confined. The average depth to the water table is 10 m while the average depth to the top of the aquifer is <5 m, and the average thickness of the aquifer system is 200 m (China). Layer 2 that is underneath layer 1 is also a single-layered system that is entirely unconfined. The average depth to the water table is 15 m while the average depth to the top of the aquifer is 15 m, and the average thickness of the aquifer system is 200 m (Kazakhstan). Layer 3 that is multiple layered and hydraulically

AS72 - Ili River

connected is mostly confined, with some parts being unconfined. The average depth to the water table is 8 m while the average depth to the top of the aquifer is 8 m, and the average thickness of the aquifer system is 1000 m (Kazakhstan).

Hydrogeological aspects
The predominant lithology is sediment – sand (layer1) and gravel (layers 2 and 3). Layer 1 is characterized by a high primary porosity with secondary porosity: fractures that has a high horizontal and vertical connectivity. It has an average transmissivity value of 4000 m^2 /day and the total groundwater volume is 22 km^3 (China). Layer 2 is characterized by a very high primary porosity with no secondary porosity. It has a high horizontal and vertical connectivity. It has an average transmissivity value of 1200 m^2 /day and the total groundwater volume is 38 km^3 (Kazakhstan). Layer 3 is characterized by a very high primary porosity with no secondary porosity. It has a high horizontal and a low vertical connectivity. The average transmissivity value is high at 4100 m^2 /d and the total groundwater volume is 390 km^3 (Kazakhstan). The average annual amount of recharge is 0.06 Mm^3/yr in layer 1 over a recharge area of 20 000 km^2 (China), and 520 Mm^3/yr in layer 2 over a recharge area of 1000 km^2 (Kazakhstan), and 1341 Mm^3/yr in layer 3 over a recharge area of 5900 km^2 (Kazakhstan). The recharge process in layer 1 is 90 % due to natural recharge processes, whereas in layers 2 and 3 it is 100% due to natural recharge processes. From the long-term trend of the water level, Layer 1 shows signs of groundwater depletion whereas layers 2 and 3 do not.

Linkages with other water systems
The predominant source of recharge for layer 1 is from glaciers (China) whereas in layers 2 and 3 it is through infiltration from surface water bodies (Kazakhstan). The natural discharge mechanism for all 3 layers is through river base flow (see appendix).

Environmental aspects
The entire aquifer is suitable for human consumption and only some of the superficial layers have elevated levels of natural salinity. No anthropogenic pollution has thus far been observed. Whereas no data is available for the percentage of shallow groundwater in layer 1, 80% of the aquifer area is covered with groundwater dependent ecosystems (China). Within layer two 7% of the aquifer area within Kazakhstan has shallow groundwater, 35 % of the aquifer area within layer 3 is characterised by shallow groundwater (Kazakhstan). No data is available on the % of these layers that are covered with groundwater dependent ecosystems.

Socio-Economic aspects
During 2010 the total amount of groundwater abstraction from the aquifer was 0.10 Mm^3 from layer 1 (China) and 0.12 Mm^3 from layer 2 and 10 Mm^3 from layer 3 (Kazakhstan). Over the same period the total amount of fresh water that was abstracted over the aquifer area within China was 2 Mm^3.

Legal and Institutional aspects
According to China there is a signed Bilateral Agreement with full scope whereas according to Kazakhstan there is no Agreement in place. Furthermore according to China a Dedicated Institution with a full mandate and capacity exists. There is no National Institute in place currently within Kazakhstan.

Emerging Issues
Institutional support and development is necessary within Kazakhstan.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Sangam Shresta	Asian Institute of Technology	Thailand	sangamshrestha@gmail.com	Regional coordinator

AS72 - Ili River

Name	Organisation	Country	E-mail	Role
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Jing He	China University Of Gesciences, Bejing	China	hejing121486@126.com	Contributing national expert
Liyan Yue	China University Of Gesciences, Bejing	China	yueliyan00120@126.com	Contributing national expert
Zaisheng Han	China University Of Gesciences, Bejing	China	hanzsh@hotmail.com	Lead National Expert
Aleksandr Kuchin	Hydrogeological research and design company "KazHYDEC" Ltd.	Kazakhstan	agkuchin@gmail.com	Contributing national expert
Oleg Podolny	Hydrogeological research and design company "KazHYDEC" Ltd.	Kazakhstan	podolnyo@mail.ru	Lead National Expert

Considerations and recommendations

Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

Both TBA countries contributed to the information. Information was adequate to describe the aquifer in general terms and the quantitative information that was also available, was generally sufficient to calculate most of the indicators as the national levels.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

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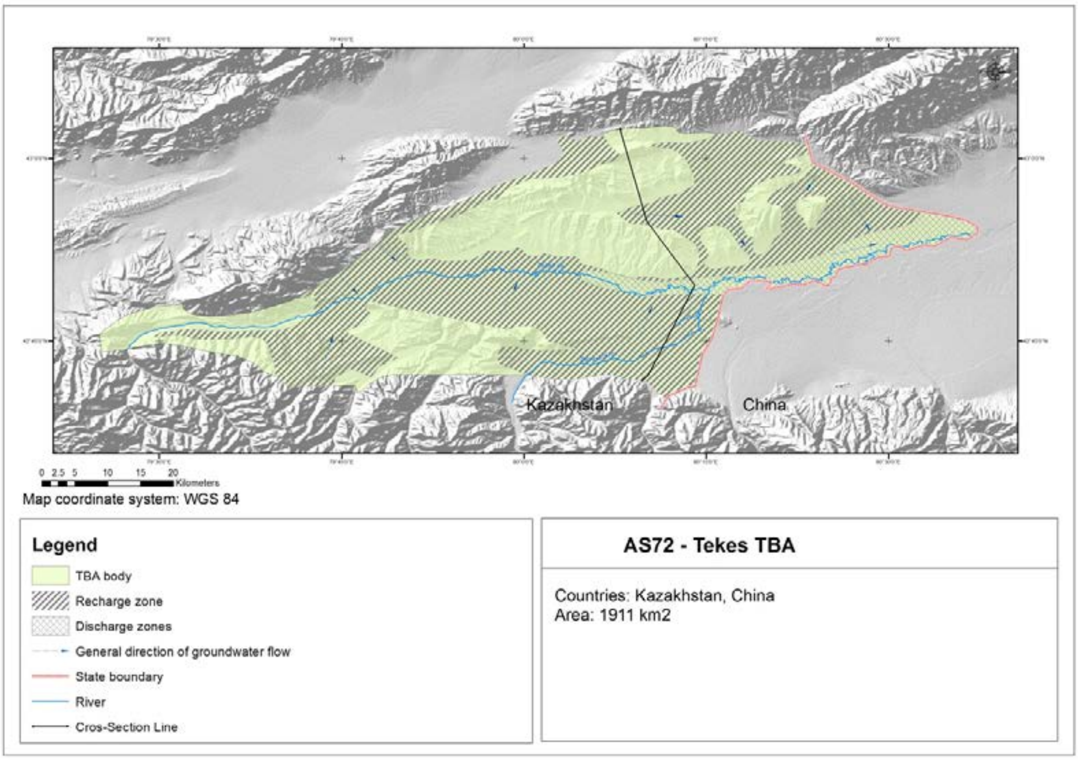
Appendix: AS72 -



Ili River: Groundwater recharge-discharge regime

Colophon

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For more information on TWAP Groundwater and for more data, please have a look at the TWAP Groundwater Information Management System which is accessible via www.twap.isarm.org or www.un-igrac.org.

Request:
If you have additional data or information about this transboundary aquifer that can improve the quality of this information sheet and the underlying database, please contact us via email at info@un-igrac.org. If appropriate, the information will be uploaded to the database of transboundary aquifers and will also be used in new versions of this information sheet.

References:
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- Rainfall: Average rainfall per TBA has been calculated based on the aquifer map and grid data for precipitation. Source precipitation data: Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. Grid data download from www.worldclim.org (2015): Data for current conditions (~1950-2000), ESRI grids, 30 arc seconds, Precipitation.
- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: May 2017

AS150 – Irtysh-Obsky

Geography

Total area TBA (km^2): 906 000

No. countries sharing: 2

Countries sharing: Kazakhstan, Russian Federation

Population: 11 700 000

Climate Zone: Humid Continental

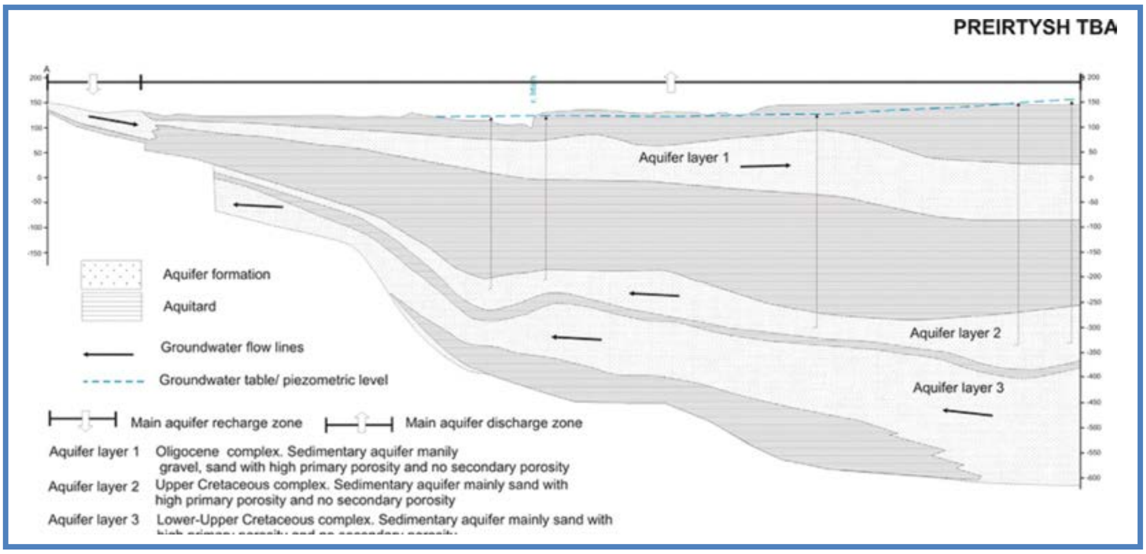
Rainfall: 390

Hydrogeology

Aquifer type: Multiple layers hydraulically connected

Degree of confinement: Mostly confined, but some parts unconfined

Main Lithology: Sediment - sand



Cross-section showing the 3 main aquifer layers (the part mainly within Kazakhstan)

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS150 – Irtysh-Obsky

TWAP Groundwater Indicators

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
Kazakhstan	5	520					14	8	D	E
Russian Federation							11		D	E
TBA level							**13**		**D**	**E**

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).
(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.
(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).
(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.
(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).
(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Primary Porosity	Secondary Porosity	Transmissivity (m^2/d)
Kazakhstan	<5	100	250	Aquifer mostly confined, but some parts unconfined	sediment – sand	High primary porosity fine/medium sedimentary deposits	No secondary porosity	750
Russian Federation	5	20	650	Aquifer mostly confined, but some parts unconfined	sediment – sand	High primary porosity fine/medium sedimentary deposits	No secondary porosity	
TBA level								

* Including aquitards/aquicludes
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

AS150 – Irtysh-Obsky

Aquifer description

Aquifer geometry

This is a multiple layered hydraulically connected system that is 3-layered within Kazakhstan and a 4-layered within the Russian Federation. The aquifer is mostly confined but some parts are unconfined. The average depth to the water table is 5 m within Russia and <5 m within Kazakhstan. The average depth to the top of the aquifer varies from 20 m (Russia) to 100 m (Kazakhstan). The average thickness of the aquifer system varies from 250 m (Kazakhstan) to 650 m (Russia).

Hydrogeological aspects

The main aquifer lithology is sediment – sand, with sand and gravel in the upper Oligocene complex and mainly sand in the Upper-Cretaceous and the Lower-Cretaceous formations. All three horizons are characterised by a high primary porosity with no secondary porosity, and furthermore by a high horizontal and a low vertical connectivity. The average transmissivity value is 750 m^2/d (Kazakhstan). The average annual recharge, that is 100 % due to natural recharge processes, has been estimated as 1375 Mm^3/yr (Kazakhstan) and the total volume of groundwater within the system is 3424 km^3.

Linkages with other water systems

The predominant source of recharge is through precipitation on the aquifer area and runoff into the aquifer area from Russia. The predominant groundwater discharge mechanism is through river base flow (Russia), and through groundwater flow into surrounding aquifers (Kazakhstan). (see appendix)

Environmental aspects

Some of the natural groundwater quality is not fit for drinking water purposes and this is mainly due to elevated levels of natural salinity over a significant portion part of the aquifer but the data is not available to determine the percentage of the aquifer area that has been affected. No noticeable anthropogenic groundwater pollution has been identified to date over the aquifer area. No data is available with regard to the extent of shallow groundwater and groundwater dependent ecosystems over the aquifer area.

Socio-economic aspects

The annual amount of groundwater abstraction from the aquifer that was measured during 2010 was 242 Mm^3. No data is available with regard to the total amount of fresh water that was abstracted over the aquifer area for the same period.

Legal and Institutional aspects

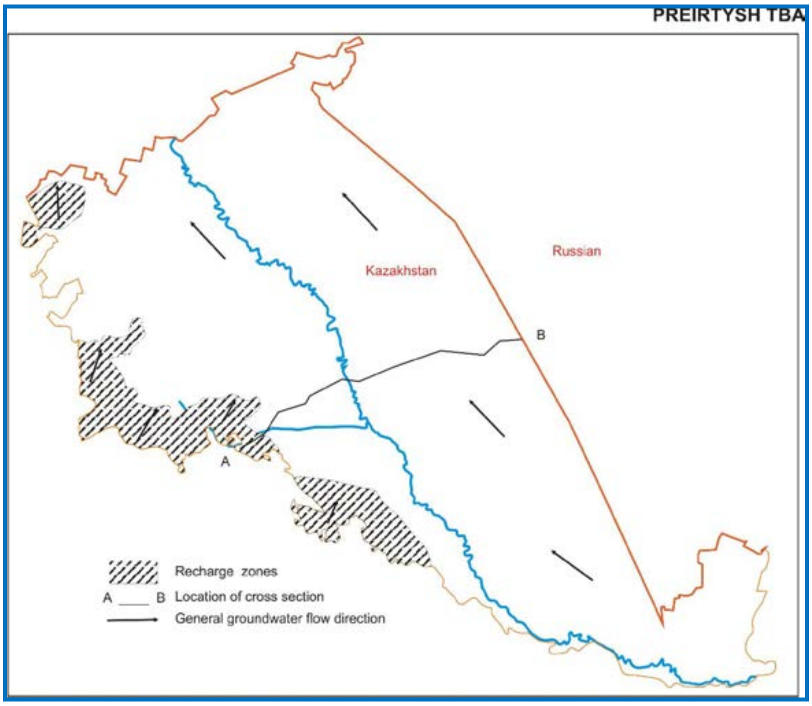
No Transboundary Agreement currently exists, nor is it currently under preparation. No Institution currently exists for TBA management.

Hot spot

This TBA is a high-yielding, fairly shallow, largely artesian groundwater resource. The aquifer is intensively exploited in Russia for water supply of large cities (Novosibirsk, Barnaul, etc.). According to groundwater monitoring data in the Russian Federation, the groundwater cone of depression as a result of these abstractions has grown to more than 50 000 km^2 and has spread to the territory of Kazakhstan. A joint investigation regarding the exploitable resources of this major transboundary groundwater resource needs to be urgently carried out. A Bi-lateral Agreement for its joint operation and sustainable development is essential.

AS150 – Irtysh-Obsky

Appendix: AS75



Preirtysh: Groundwater recharge zones

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Abdelkader Dodo	Observatoire du Sahara et du Sahel	Tunisia	abdelkader.dodo@oss.org.tn	Regional coordinator
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Yusuf Al-Mooji		Lebanon	mooji46@yahoo.com	Regional coordinator
Aleksandr Kuchin	Hydrogeological research and design company "KazHYDEC" Ltd.	Kazakhstan	agkuchin@gmail.com	Contributing national expert
Oleg Podolny	Hydrogeological research and design company "KazHYDEC" Ltd.	Kazakhstan	podolnyo@mail.ru	Lead National Expert
Boris Korolev	Federal state unitary geological organization "Hydrospecialgeology"	Russia	korolyev@mail.ru	Contributing national expert

Considerations and recommendations

Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

Both TBA countries have contributed to the information. Some quantitative information was also available, and some of the indicators could be calculated.

AS150 – Irtysh-Obsky

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

Colophon

This Transboundary Aquifers information sheet has been produced as part of the Groundwater Component of the GEF Transboundary Water Assessment Programme (GEF TWAP). **GEF TWAP** is the first truly global comparative assessment of transboundary groundwater, lakes, rivers, large marine ecosystems and the open ocean. More information on TWAP can be found on: www.geftwap.org . **The Groundwater component** of TWAP carried out a global comparison of 199 transboundary aquifers and the groundwater systems of 41 Small Island Developing States. The data used to compile this transboundary aquifer information sheet has been made available by national and regional experts from countries involved in the TWAP Groundwater project. For aquifers larger than 20 000 km2 and which are not overlapping, additional data are available from modelling done by the Goethe University Frankfurt (Germany) as part of TWAP Groundwater. All data were compiled by UNESCO-IHP and the International Groundwater Resources Assessment Centre (IGRAC – UNESCO Category II Institute). Values given in the fact-sheet represent an approximate guide only and should not replace data obtained from recent local assessments. The editors of this information sheet are not responsible for the quality of the data.

For more information on TWAP Groundwater and for more data, please have a look at the TWAP Groundwater Information Management System which is accessible via www.twap.isarm.org or www.un-igrac.org.

Request:
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References:
- Population: Population has been calculated based on the aquifer map and grid information on population. Source population data: Center for International Earth Science Information Network - CIESIN - Columbia University, United Nations Food and Agriculture Programme - FAO, and Centro Internacional de Agricultura Tropical - CIAT. 2005. Gridded Population of the World, Version 3 (GPWv3): Population Count Grid, Future Estimates. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H42B8VZZ. Accessed Jan 2015.
- Rainfall: Average rainfall per TBA has been calculated based on the aquifer map and grid data for precipitation. Source precipitation data: Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. Grid data download from www.worldclim.org (2015): Data for current conditions (~1950-2000), ESRI grids, 30 arc seconds, Precipitation.
- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: October 2015

AS119 - Karst Aquifer of Upper Zuojiang Valley

Geography

Total area TBA (km^2): 19 000

No. countries sharing: 2

Countries sharing: China, Vietnam

Population: 1 900 00

Climate Zone: Humid Subtropical

Rainfall (mm/yr): 1500

Hydrogeology

Aquifer type: Single layered

Degree of confinement: Entire aquifer unconfined

Main Lithology: Sediment - sand

No Cross-section provided

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS119 - Karst Aquifer of Upper Zuojiang Valley

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
China	<1	<1	100	50	2800		100	>1000	A	A
Viet Nam							94			
TBA level							**98**			

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).
(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.
(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).
(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.
(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).
(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
China	10	<5	240	Whole aquifer unconfined	Sediment - Sand	High primary porosity fine/ medium sedimentary deposits	Secondary porosity: Fractures	5000
Viet Nam								
TBA level								

* Including aquitards/aquicludes
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Aquifer description

As most of the information was provided by China, most of the values within this brief refer to the portion of the TBA within China.

AS119 - Karst Aquifer of Upper Zuojiang Valley

Aquifer geometry
This aquifer is single layered system and the entire aquifer is unconfined. The average depth to the water table is 10 m. This aquifer protrudes to the surface and the average thickness of the aquifer system is 240m.

Hydrogeological aspects
The predominant aquifer lithology is sediment – sand that has a high primary porosity with secondary porosity: fractures. The formation is also characterised by a high horizontal and vertical connectivity. The average transmissivity value is relatively high at 5000 m^2/d. The total groundwater volume within the system is 16 km^3. The average recharge into the system is 12 Mm^3/yr and the aerial extent of the major recharge area is over 32 000km^2. The long-term trend does indicate signs of groundwater depletion that is probably due to over-pumping but the amounts needs to be verified.

Linkages with other water systems
The predominant source of recharge is through precipitation over the aquifer area. The major discharge mechanism is through river base flow.

Environmental aspects
The natural groundwater quality is suitable for human consumption with only some superficial layers having a higher level of natural salinity. Besides minor amounts of pollution on parts of the superficial layers, no anthropogenic groundwater pollution has been recorded. Within China around 30% of the aquifer is characterised by shallow groundwater whereas 80% of the TBA is covered with groundwater dependent ecosystems.

Socio-economic aspects
A total of 3 Mm^3 of water was abstracted from the system during 2010 within China. A total amount of 6 Mm^3 of fresh water was abstracted over the aquifer area for the same year.

Legal and Institutional aspects
According to China a Bilateral Agreement with full scope for TBA management signed by all parties does exist. Furthermore a Dedicated Transboundary Institution is fully operational.

Emerging Issues
The extent of groundwater depletion that is probably due to over-pumping needs to be verified and control measures should be put in place.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Sangam Shresta	Asian Institute of Technology	Thailand	sangamshrestha@gmail.com	Regional coordinator
Yao Li	China University of Gesciences, Bejing	China	ly2752@163.com	Contributing national expert
Jing He	China University of Gesciences, Bejing	China	hejing121486@126.com	Contributing national expert
Liyan Yue	China University of Gesciences, Bejing	China	yueliyan00120@126.com	Contributing national expert
Zaisheng Han	China University of Gesciences, Bejing	China	hanzsh@hotmail.com	Lead National Expert

AS119 - Karst Aquifer of Upper Zuojiang Valley

Considerations and recommendations

Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

One of the TBA countries contributed to the information. The information was adequate to describe the aquifer in general terms. Quantitative information was also available, and the indicators at the national level could also be calculated.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

Colophon

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- All other data: TWAP Groundwater (2015).

Version: May 2017

AS87 - Middle Heilongjiang - Amur River Basin

Geography

Total area TBA (km^2): 110 000

No. countries sharing: 2

Countries sharing: China, Russian Federation

Population: 3 500 000

Climate Zone: Humid Continental

Rainfall (mm/yr): 640

Hydrogeology

Aquifer type: Data not available

Degree of confinement: Data not available

Main Lithology: Data not available

No cross-section available

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS87 - Middle Heilongjiang - Amur River Basin

TWAP Groundwater Indicators from Global Inventory

No data available.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita: Current state (m^3/y/capita)	Renewable groundwater per capita: Projection 2030 (% change to current state)	Renewable groundwater per capita: Projection 2050 (% change to current state)	Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
China	97	1600	4	17	48	41	51	24
Russian Federation	170	16 000	10	24	30	33	34	25
TBA level	**140**	**5100**	**4**	**17**	**45**	**37**	**51**	**25**

	Groundwater depletion (mm/y)	Population density: Current state (Persons/km2)	Population density: Projection 2030 (% change to current state)	Population density: Projection 2050 (% change to current state)	Groundwater development stress: Current state (%)	Groundwater development stress: Projection 2030 (% point change to current state)	Groundwater development stress: Projection 2050 (% point change to current state)
China	-1	59	3	-7	12	2	4
Russian Federation	-1	11	-4	-14	<1	0	0
TBA level	**-1**	**28**	**1**	**-8**	**3**	**1**	**1**

Key parameters table from Global Inventory

No data available.

Aquifer description

No data available.

Contributors to Global Inventory

No contributions.

Considerations and recommendations

Request:
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Colophon

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AS87 - Middle Heilongjiang - Amur River Basin

transboundary aquifers and the groundwater systems of 41 Small Island Developing States. The data used to compile this transboundary aquifer information sheet has been made available by national and regional experts from countries involved in the TWAP Groundwater project. For aquifers larger than 20 000 km2 and which are not overlapping, additional data are available from modelling done by the Goethe University Frankfurt (Germany) as part of TWAP Groundwater. All data were compiled by UNESCO-IHP and the International Groundwater Resources Assessment Centre (IGRAC – UNESCO Category II Institute). Values given in the fact-sheet represent an approximate guide only and should not replace data obtained from recent local assessments. The editors of this information sheet are not responsible for the quality of the data.

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References:

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- Rainfall: Average rainfall per TBA has been calculated based on the aquifer map and grid data for precipitation. Source precipitation data: Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. Grid data download from www.worldclim.org (2015): Data for current conditions (~1950-2000), ESRI grids, 30 arc seconds, Precipitation.
- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: October 2015

AS81 - Nu River Valley Aquifer

Geography

Total area TBA (km^2): 18 000

No. countries sharing: 2

Countries sharing: Myanmar, China

Population: 1 800 000

Climate Zone: Humid Subtropical

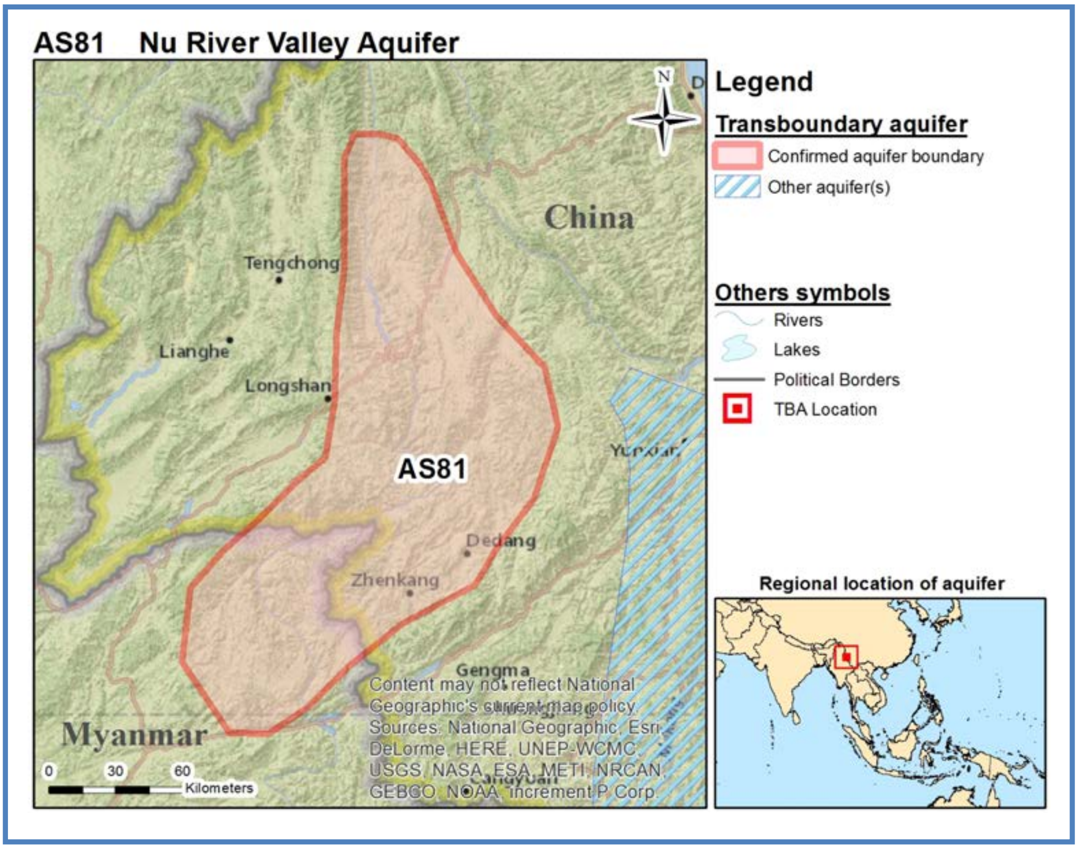
Rainfall (mm/yr): 1300

Hydrogeology

Aquifer type: Multiple layered hydraulically connected system

Degree of confinement: Mostly unconfined, but some parts confined

Main Lithology: Sediment – sand



No Cross-section Provided

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS81 - Nu River Valley Aquifer

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
China	<1	<1	100	40	1500		120	>1000	A	A
Myanmar							39			
TBA level							**100**			

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).
(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.
(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).
(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.
(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).
(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
China	10	<5	200	Aquifer mostly unconfined, but some parts confined	Sediment - Sand	High primary porosity fine/ medium sedimentary deposits	Secondary porosity: fractures	4000
Myanmar								
TBA level								

* Including aquitards/aquicludes
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

AS81 - Nu River Valley Aquifer

Aquifer description

Aquifer geometry

This aquifer is a multiple-layered hydraulically connected system that is mostly unconfined, but some parts are confined. The average depth to the water table is 10m within China. The average depth to the top of the aquifer is <5 m while the average thickness of the aquifer system is 200m.

Hydrogeological aspects

The predominant aquifer lithology is sediment – sand that has a high primary porosity with secondary porosity: fractures. It has a high horizontal and vertical connectivity. The average transmissivity value is relatively high at 4000 m^2/d. The total groundwater volume within the system in China is 30 km^3. The average amount of recharge into the system within China that was provided should be reviewed and the aerial extent of the major recharge area is 25 000km^2. There is an annual amount of groundwater depletion that has occurred, probably due to over-pumping, but the realistic amount based on the groundwater trends must be reviewed.

Linkages with other water systems

The predominant source of natural recharge is through precipitation over the aquifer area. The major discharge mechanism within China is through river base flow.

Environmental aspects

With regard to the natural groundwater quality within China, besides some superficial areas with higher salinity levels and elevated amounts of Fluoride, the entire aquifer is generally suitable for human consumption. Currently besides some of the superficial layers being slightly polluted through landfills and waste disposal sites, no larger-scale anthropogenic groundwater pollution has been detected. Around 20% of the aquifer within China is characterised by shallow groundwater, whereas around 80% of the aquifer area is covered with groundwater dependent ecosystems.

Socio-economic aspects

A total of 2 Mm^3 of water was abstracted from the system during 2010 within China. The total amount of fresh water that was abstracted over the aquifer area over the same period was 5 Mm^3.

Legal and Institutional aspects

According to China there is a signed Bilateral Agreement with full scope, where there is also a Transboundary Institute with full a full mandate and capacity.

Emerging Issues

The current status of the institutional set-up and capacity within Burma should be reviewed.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Sangam Shresta	Asian Institute of Technology	Thailand	sangamshrestha@gmail.com	Regional coordinator
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Jing He	China University of Gesciences, Bejing	China	hejing121486@126.com	Contributing national expert
Liyan Yue	China University of Gesciences, Bejing	China	yueliyan00120@126.com	Contributing national expert
Zaisheng Han	China University of Gesciences, Bejing	China	hanzsh@hotmail.com	Lead National Expert

AS81 - Nu River Valley Aquifer

Considerations and recommendations

Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

Only 1 of the 2 TBA countries contributed to the information. Information was adequate to describe the aquifer in general terms. The quantitative information that was also available, was sufficient to calculate most of the indicators at the national level.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

Colophon

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References:

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- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: May 2017

AS19 - Pre-Caspien

Geography

Total area TBA (km^2): 180 000

No. countries sharing: 2

Countries sharing: Azerbaijan, Iran

Population: 1 700 000

Climate Zone: Semi-arid

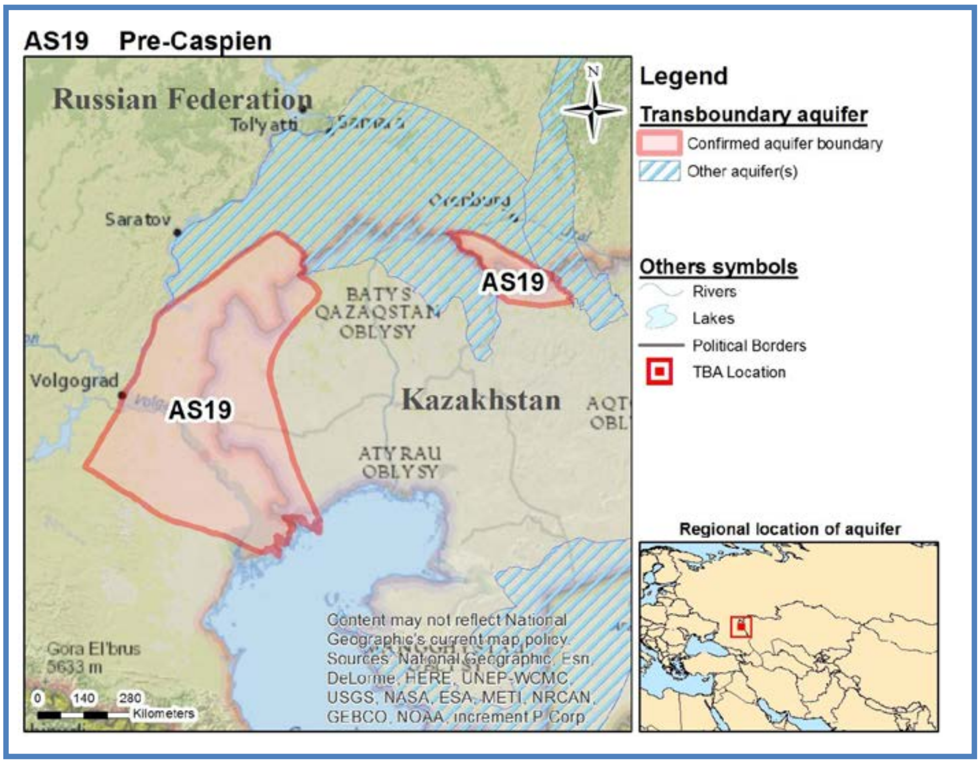
Rainfall (mm/yr): 290

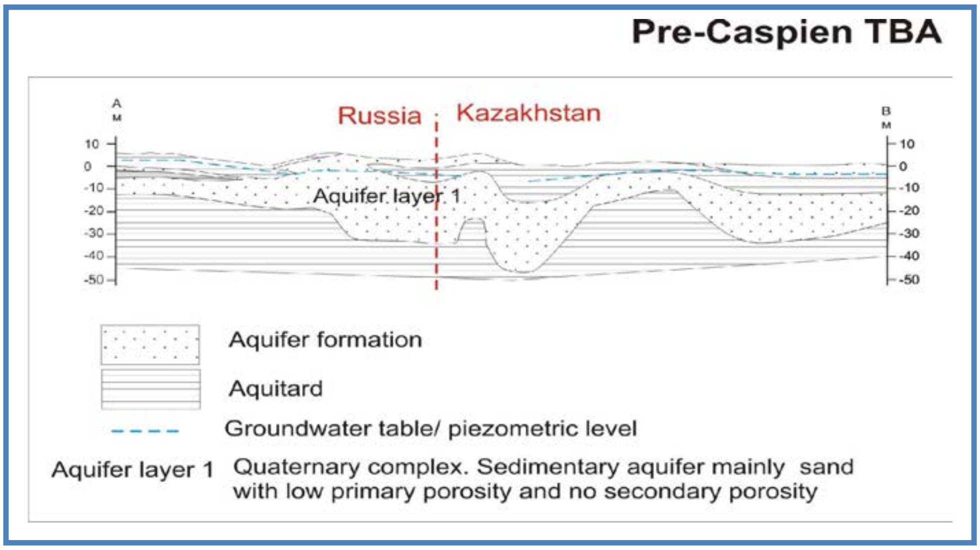
Hydrogeology

Aquifer type: Single-layered

Degree of confinement: Mostly semi-confined, but with some parts unconfined.

Main Lithology: Sediment – sand and sedimentary rocks – sandstones





Cross-section over part of the Transboundary Aquifer

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS19 - Pre-Caspien

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
Kazakhstan			5		0		2		D	E
Russian Federation			5		0		12		D	E
TBA level			**5**		**0**		**10**		**D**	**E**

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).

(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.

(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).

(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.

(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).

(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
Kazakhstan	26	9900	-5	-7	17	30	11	35
Russian Federation	200	16 000	7	19	11	13	12	6
TBA level	**150**	**16 000**	**6**	**16**	**11**	**14**	**12**	**6**

AS19 - Pre-Caspien

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
Kazakhstan	0	3	11	17	1	0	0
Russian Federation	0	12	-6	-14	<1	0	0
TBA level	**0**	**9**	**-4**	**-12**	<1	**0**	**0**

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
Kazakhstan	5	10	20	Aquifer mostly semi-confined, but some parts unconfined	Sediment - Sand	Low Primary porosity intergranular porosity	No Secondary porosity	200
Russian Federation	10	10	25	Aquifer mostly semi-confined, but some parts unconfined	Sediment - Sand	High Primary porosity fine/ medium sedimentary deposits	No Secondary porosity	
TBA level								

* Including aquitards/aquicludes

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Aquifer description

Aquifer geometry

This is a single-layered aquifer in both countries. The average depth to the water table varies between 5 and 10m. The average depth to the top of the aquifer is 10m and the thickness of the entire aquifer system varies between 20m and 25m. The aquifer is mostly semi-confined, but with some parts unconfined.

Hydrogeological aspects

The predominant lithology is Sediment – sand. It has a low to high primary porosity with no secondary porosity and a low horizontal connectivity. The average transmissivity is around 200m^2/day in both countries. Recharge into the system is 100% through natural recharge.

Linkages with other water systems

Precipitation on the aquifer area is the predominant source of recharge and evapotranspiration and river base flow the predominant groundwater discharge mechanism.

AS19 - Pre-Caspien

Environmental aspects
In both countries groundwater is not suitable for human consumption in over 95% of the aquifer area on the superficial layers as a result of elevated natural salinity. Very little to no pollution has been identified. No information on shallow groundwater or on groundwater dependent ecosystems has been recorded.

Socio-economic aspects
The mean annual groundwater abstraction in Russia is 0.5 Mm^3/annum and 0 in Kazakhstan. No groundwater depletion is occurring. The total amount of fresh water abstraction over the aquifer area has not been recorded.

Legal and Institutional aspects
No Transboundary Agreement is in place. Although it is reported that in both countries there is no National Institution in place with the appropriate mandate, groundwater abstraction, groundwater quality protection, and drilling control are done according to law/ regulations, and measures are also applied in practice.

Emerging Issues
No significant groundwater abstraction is occurring near the border. Once the Koyandy well-field in Kazakhstan near the Russian border comes into operation, appropriate joint monitoring of the aquifer system becomes a priority.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Dmitrii Plaksin		Kyrgyzstan	plaksind@ya.ru	Regional coordinator
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Considerations and recommendations

Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

Both countries have provided data to describe the aquifer adequately, but there was not enough numerical information to allow calculation of groundwater indicators at the transboundary level.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

AS19 - Pre-Caspien

Colophon

This Transboundary Aquifers information sheet has been produced as part of the Groundwater Component of the GEF Transboundary Water Assessment Programme (GEF TWAP). **GEF TWAP** is the first truly global comparative assessment of transboundary groundwater, lakes, rivers, large marine ecosystems and the open ocean. More information on TWAP can be found on: www.geftwap.org . **The Groundwater component** of TWAP carried out a global comparison of 199 transboundary aquifers and the groundwater systems of 41 Small Island Developing States. The data used to compile this transboundary aquifer information sheet has been made available by national and regional experts from countries involved in the TWAP Groundwater project. For aquifers larger than 20 000 km2 and which are not overlapping, additional data are available from modelling done by the Goethe University Frankfurt (Germany) as part of TWAP Groundwater. All data were compiled by UNESCO-IHP and the International Groundwater Resources Assessment Centre (IGRAC – UNESCO Category II Institute). Values given in the fact-sheet represent an approximate guide only and should not replace data obtained from recent local assessments. The editors of this information sheet are not responsible for the quality of the data.

For more information on TWAP Groundwater and for more data, please have a look at the TWAP Groundwater Information Management System which is accessible via www.twap.isarm.org or www.un-igrac.org.

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- All other data: TWAP Groundwater (2015).

Version: December 2015

AS96 - Shishhid River Aquifer

Geography

Total area TBA (km^2): 23 000

No. countries sharing: 2

Countries sharing: Mongolia, Russia

Population: 21 000

Climate Zone: Subarctic

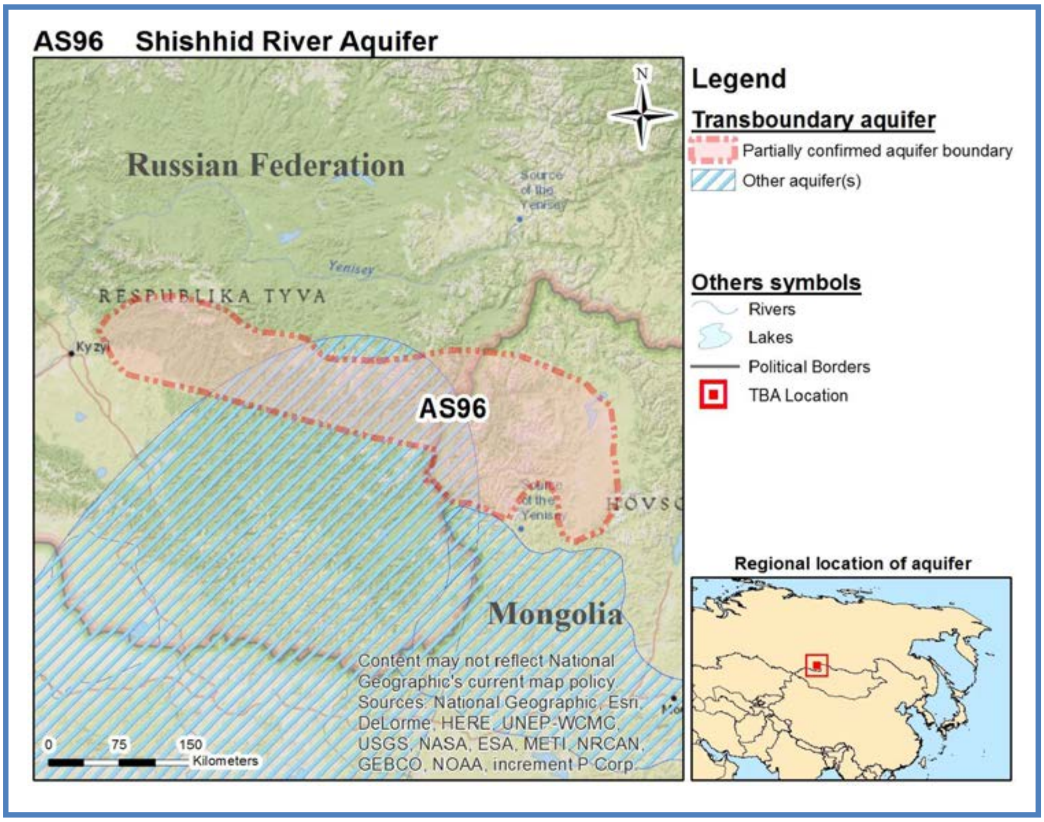
Rainfall (mm/yr): 380

Hydrogeology

Aquifer type: Single layered system

Degree of confinement: Entire aquifer is unconfined

Main Lithology: Sediment - gravel



No cross-section available

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS96 - Shishhid River Aquifer

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
Mongolia	210	150000	70	45			1	<5	B	D
Russian Federation							1			
TBA level							**1**			

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).
(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.
(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).
(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.
(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).
(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change from current state)	Projection 2050 (% change to current state)				
Mongolia	5	3400	-15	-25	74	73	0	80
Russian Federation	16	23 000	22	39	20	20	18	80
TBA level	**11**	**11 000**	**-1**	**-4**	**38**	**38**	**18**	**80**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
Mongolia	0	1	28	49	1	1	3
Russian Federation	0	1	-4	-11	<1	0	0
TBA level	**0**	**1**	**16**	**26**	**<1**	**0**	**1**

AS96 - Shishhid River Aquifer

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
Mongolia	<5	<5	37	Whole aquifer unconfined	Sediment - Gravel	Low primary porosity intergranular porosity	No secondary porosity	32
Russian Federation								
TBA level								

* Including aquitards/aquicludes

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Aquifer description

As most of the information was provided by Mongolia, most of the values within this brief refer to the portion of the TBA within Mongolia.

Aquifer geometry

This aquifer is a single-layered system and the entire aquifer is unconfined. The average depth to the water table is <5 m, and the average depth to the top of the aquifer is also <5 m while the average thickness of the aquifer system is 37 m.

Hydrogeological aspects

The predominant aquifer lithology is sediment - gravel that has a low inter-granular primary porosity with no secondary porosity. It furthermore has a high horizontal and vertical connectivity. The average transmissivity value is 32 m^2/d. The average recharge into the system also needs to be reviewed and the aerial extent of the major recharge area is over 20 100 km^2 (see appendix).

Linkages with other water systems

The predominant source of recharge is through precipitation over the aquifer area. The predominant discharge mechanism is through river base flow.

Environmental aspects

A total amount of 30% of the natural groundwater quality is unfit for human consumption over a significant part of the aquifer due mainly to natural salinity and the extreme hardness of the water. Furthermore no anthropogenic groundwater pollution over the aquifer area has been identified. Around 15% of the aquifer within Mongolia is characterised by shallow groundwater whereas 5% of the aquifer area is covered by groundwater dependent ecosystems.

Socio-economic aspects

A total amount of 0.30 Mm^3 of groundwater was abstracted from the system during 2010 within Mongolia. The total amount of fresh water abstraction over the aquifer area was 0.68 Mm^3.

Legal and Institutional aspects

According to Mongolia a Bi-lateral Agreement with limited scope for TBA management signed by all parties does exists. Furthermore the National institution is in place, but it is not fully operational.

Emerging Issues

Joint monitoring work would be a good platform for future cooperation.

AS96 - Shishhid River Aquifer

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Sangam Shresta	Asian Institute of Technology	Thailand	sangamshrestha@gmail.com	Regional coordinator
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Considerations and recommendations

Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

One of the TBA countries contributed to the information. The information was adequate to describe the aquifer in general terms. Some quantitative information was also available, and most of the indicators at the national level could also be calculated. The total groundwater volume within Mongolia needs to be reviewed. The average recharge into the system also needs to be reviewed.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

Appendix: AS96 –

Showing Recharge zones of the Shishhid River Aquifer within Mongolia

AS96 - Shishhid River Aquifer

Colophon

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- All other data: TWAP Groundwater (2015).

Version: October 2015

AS31 - South-Pred-Ural

Geography

Total area TBA (km^2): 88 000

No. countries sharing: 2

Countries sharing: Kazakhstan, Russian Federation

Population: 1 800 000

Climate Zone: Subartic

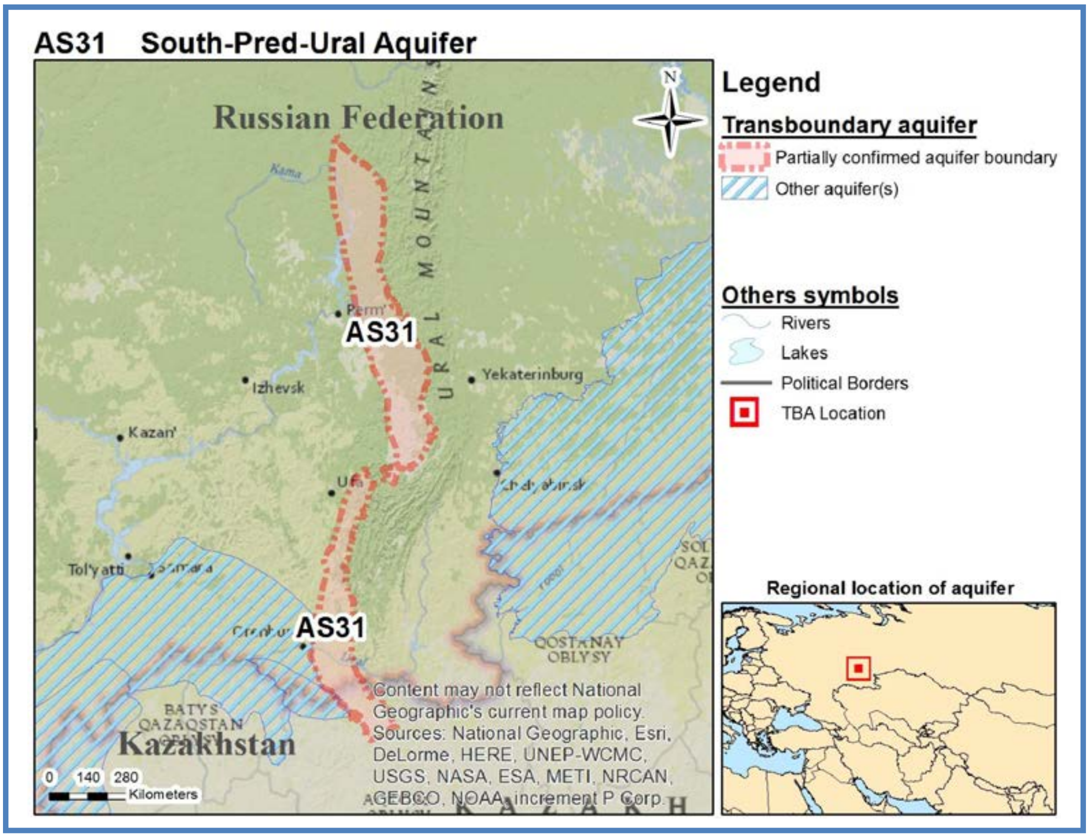
Rainfall (mm/yr): 540

Hydrogeology

Aquifer type: Multiple-layered hydraulically connected

Degree of confinement: Mostly confined, but some parts unconfined

Main Lithology: Sediments - sands and sedimentary rocks - sandstone



No cross-section available

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS31 - South-Pred-Ural

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
Kazakhstan	30	980			0		31	10	D	E
Russian Federation					0		19		D	E
TBA level					**0**		**21**		**D**	**E**

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).

(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.

(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).

(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.

(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).

(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
Kazakhstan	5	5	170	Aquifer mostly confined, but some parts unconfined	Sediment - Sand	High primary porosity fine/medium sedimentary deposits	No secondary porosity	940
Russian Federation	5	5	60	Aquifer mostly confined, but some parts unconfined	Sediment - Sand	High primary porosity fine/medium sedimentary deposits	No secondary porosity	
TBA level								

* Including aquitards/aquicludes

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

AS31 - South-Pred-Ural

Aquifer description

Aquifer geometry

Regionally this is multiple-layered hydraulically connected system consisting of 4 main layers. The average depth to the piezometric water level is 5m. The average depth to the top of the shallower aquifer is 5m. The average thickness of the aquifer system varies from 60m within Russia to 170m within Kazakhstan. The aquifer is mostly confined, but some parts are unconfined.

Hydrogeological aspects

The predominant lithology is sediments – sands that is underlain by sedimentary rocks – sandstone. The formations have a low to high primary porosity and no secondary porosity and a high horizontal and a low vertical connectivity. The average transmissivity value is 940m^2/day (Kazakhstan). The total groundwater volume is 110km^3. The mean annual recharge is 280Mm^3/annum.

Linkages with other water systems

Recharge is predominantly through precipitation over the aquifer area, while the predominant discharge mechanism is through river base flow.

Environmental aspects

Within Russia the natural quality of the groundwater on some sites does not satisfy drinking water standards due to the high natural salinity levels but the percentage of the aquifer affected was not quantified. The level of anthropogenic pollution is still low in Russia. No information is available on shallow groundwater and on groundwater-dependent ecosystems. No such environmental information is available for Kazakhstan.

Socio-economic aspects

During 2010 the annual groundwater abstraction from the system was 22 Mm^3/annum and that was mainly used for domestic purposes within Kazakhstan, whereas that in Russia was 250 Mm^3/annum. The total amount of fresh water that was abstracted over the aquifer area was not recorded. There appear to be no signs of groundwater depletion.

Legal and Institutional aspects

No information was recorded with regard to the current status of transboundary legal and institutional matters. Information was also not recorded with regard to the status of the mandate and capacity for groundwater management of national institutions.

Emerging Issues

Groundwater abstraction in Russia is much higher than in Kazakhstan and is close to the estimated mean annual recharge of the aquifer. However, the countries report that both within Russia and Kazakhstan, no significant groundwater abstraction is taking place close to the border and so no major issues have been listed. Steps for joint monitoring of abstraction, water levels and water quality of this productive and vulnerable transboundary resource should however be taken as a matter of urgency and a bilateral agreement on joint use should be reached.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Dmitrii Plaksin		Kyrgyzstan	plaksind@ya.ru	Regional coordinator
Lucila Candela	Universidad Politécnica de Catalunya	Spain	Lucila.Candela@upc.edu	Regional coordinator
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AS31 - South-Pred-Ural

Name	Organisation	Country	E-mail	Role
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Boris Korolev	Federal state unitary geological organization "Hydrospecialgeology"	Russia	korolyev@mail.ru	Contributing national expert

Considerations and recommendations

Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

Both countries have provided data to describe the aquifer adequately, but there was not enough numerical information to allow calculation of groundwater indicators at the transboundary level

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

Colophon

This Transboundary Aquifers information sheet has been produced as part of the Groundwater Component of the GEF Transboundary Water Assessment Programme (GEF TWAP). **GEF TWAP** is the first truly global comparative assessment of transboundary groundwater, lakes, rivers, large marine ecosystems and the open ocean. More information on TWAP can be found on: www.geftwap.org . **The Groundwater component** of TWAP carried out a global comparison of 199 transboundary aquifers and the groundwater systems of 41 Small Island Developing States. The data used to compile this transboundary aquifer information sheet has been made available by national and regional experts from countries involved in the TWAP Groundwater project. For aquifers larger than 20 000 km2 and which are not overlapping, additional data are available from modelling done by the Goethe University Frankfurt (Germany) as part of TWAP Groundwater. All data were compiled by UNESCO-IHP and the International Groundwater Resources Assessment Centre (IGRAC – UNESCO Category II Institute). Values given in the fact-sheet represent an approximate guide only and should not replace data obtained from recent local assessments. The editors of this information sheet are not responsible for the quality of the data.

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- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: December 2015

AS36 - Syr Daria

Geography

Total area TBA (km^2): 300 000

No. countries sharing: 2

Countries sharing: Kazakhstan, Uzbekistan

Population: 1 800 000

Climate Zone: Arid

Rainfall (mm/yr): 160

Hydrogeology

Aquifer type: Multiple-layered hydraulically connected

Degree of confinement: Mostly confined, but some parts unconfined

Main Lithology: Sediments – sand and gravel

No cross-section available

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS36 - Syr Daria

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
Kazakhstan	15	2000			0		8	<5	D	E
Uzbekistan							3			
TBA level							**6**			

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).
(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.
(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).
(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.
(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).
(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
Kazakhstan	240	38 000	-20	-32	4	37	3	19
Uzbekistan	2	560	-15	-19	50	91	4	37
TBA level	**150**	**30 000**	**-22**	**-34**	**5**	**52**	**3**	**19**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
Kazakhstan	2	6	20	35	1	0	0
Uzbekistan	0	3	31	51	20	11	15
TBA level	**1**	**5**	**22**	**38**	**1**	**0**	**0**

AS36 - Syr Daria

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
Kazakhstan	20	20	930	Aquifer Mostly confined, but some parts unconfined	Sediment - Sand	High Primary porosity fine/ medium sedimentary deposits	No Secondary porosity	3300
Uzbekistan								
TBA level								

* Including aquitards/aquicludes
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Aquifer description

All the information in the database is from Kazakhstan only. The regional report contains some general aquifer information.

Aquifer geometry
The aquifer is a multiple 3-layered hydraulically connected system that is mostly confined but some parts are unconfined. The average depth to the water table is 20m within Kazakhstan, where the average depth to the top of the aquifer is also 20m and the average thickness of the aquifer system is 930m. The described basin occupies a huge part of the Turan Depression.

Hydrogeological aspects
A confining layer of the Paleogene age (100 m in thickness) separates two hydrogeological levels:
A top level: Pliocene-Quaternary complex - sedimentary aquifer mainly gravel, sand with high primary porosity and no secondary porosity and a middle level: Cretaceous complex - sedimentary aquifer mainly sand with high primary porosity and no secondary porosity. The average transmissivity is 3 300 m^2/d. The annual recharge is estimated at 2 800 Mm^3/annum and total groundwater volume as 9 900 km^3.

Linkages with other water systems
The top aquifer is recharged by inflows of interstitial and karst waters from overlying Paleozoic rocks. Recharge also occurs by infiltration of rainfall, surface waters from rivers and streams, and groundwater that circulates through tectonic discontinuities. The regional direction of the groundwater flow is towards the local base level, the Aral Sea (see Appendix).

Environmental aspects
Groundwater in a significant part of the aquifer in Kazakhstan is not fit for human consumption due to elevated salinity. The chemical composition and TDS contents vary to a great extent depending on the location of recharge areas and water sources: from 100 mg/l near rivers and canals to 70 000 mg/l in non-irrigated areas. No pollution has been identified.

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Socio-economic aspects

The mean annual volume of groundwater abstraction in Kazakhstan is 120Mm³/annum, largely for domestic use. This is less than 5% of the available recharge and no water level depletion has been observed.

Legal and Institutional aspects

There is no agreement between countries at this stage and also no national institution with a mandate for groundwater management. . However groundwater abstraction, groundwater quality protection, and drilling control are done according to law/ regulations, and measures are also applied in practice.

Priority Issues

Due to the small population and the low intensity of use of groundwater, there are no transboundary issues at present. Monitoring the groundwater contribution to the Aral Sea water balance is vital in the light of the major environmental disaster here.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Dmitrii Plaksin		Kyrgyzstan	plaksind@ya.ru	Regional coordinator
Aleksandr Kuchin	Hydrogeological research and design company "KazHYDEC" Ltd.	Kazakhstan	agkuchin@gmail.com	Contributing national expert
Oleg Podolny	Hydrogeological research and design company "KazHYDEC" Ltd.	Kazakhstan	podolnyo@mail.ru	Lead National Expert

Considerations and recommendations

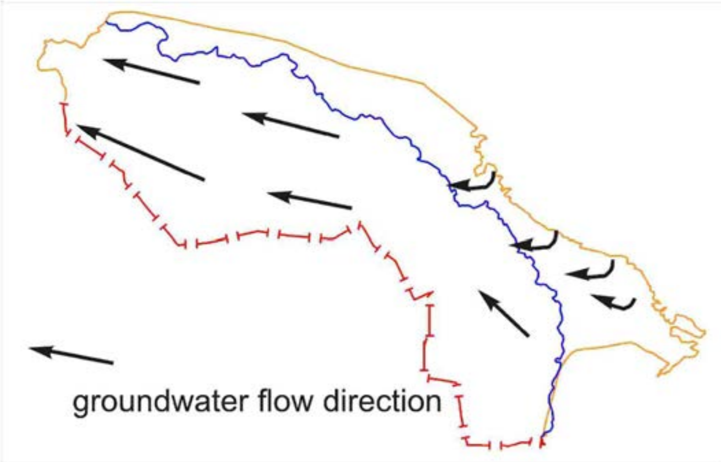
Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

Only one of the two aquifer states has supplied information that allowed adequate description of the aquifer and calculation of some of the groundwater parameters.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

AS36 - Syr Daria

Appendix: AS36



Syr Daria: Groundwater flow directions

Colophon

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- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: December 2015

AS11 - Syrt

Geography

Total area TBA (km^2): 160 000

No. countries sharing: 2

Countries sharing: Russia, Kazakhstan

Population: 3 600 000

Climate Zone: Semi-arid

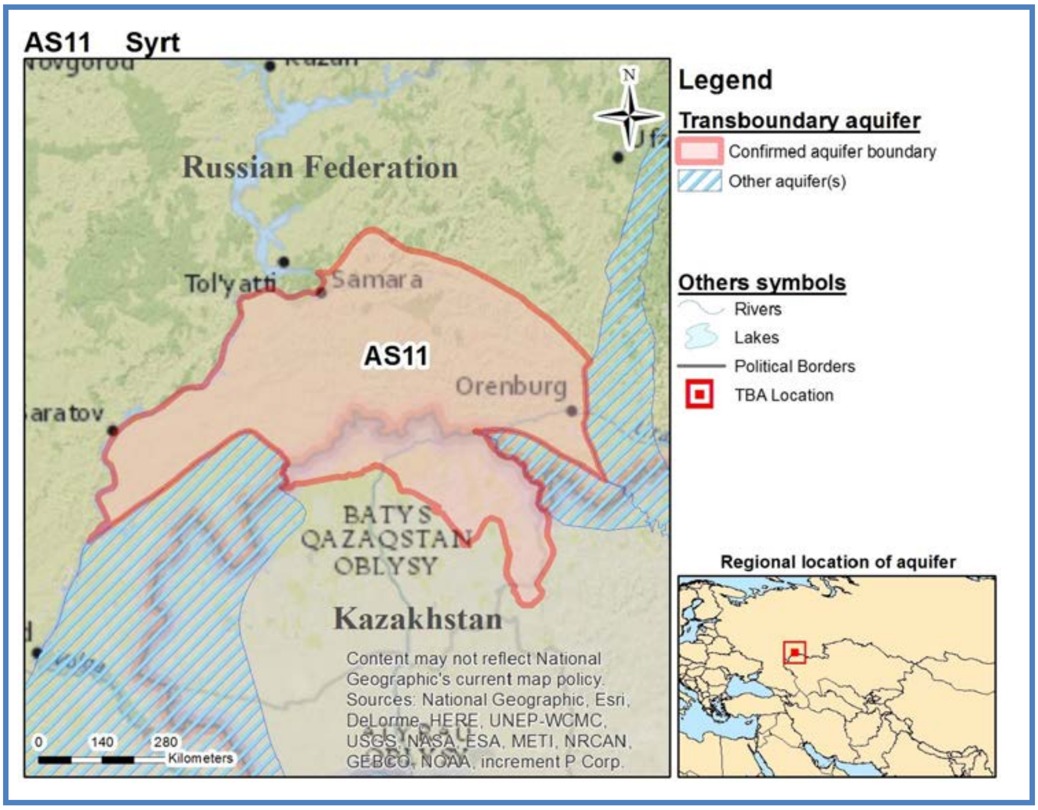
Rainfall (mm/yr): 420

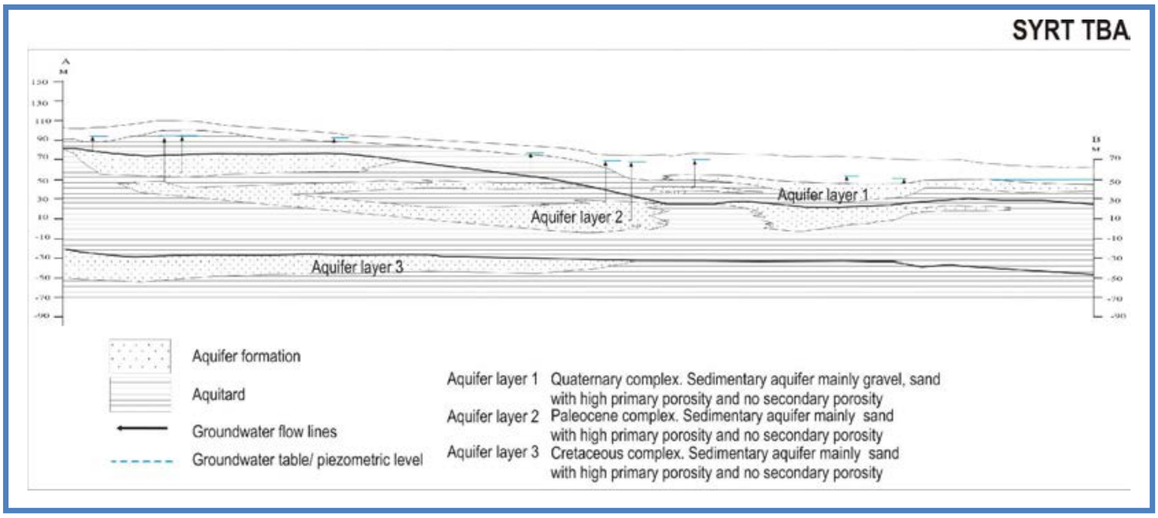
Hydrogeology

Aquifer type: Multiple-layered hydraulically connected

Degree of confinement: Mostly unconfined, but some parts are confined

Main Lithology: Sediment - Sand





Hydrogeological cross-section of the Syrt Transboundary Aquifer

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS11 - Syrt

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
Kazakhstan	2	200			0		11	15	D	E
Russian Federation					0		26		D	E
TBA level					**0**		**23**		**D**	**E**

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).

(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.

(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).

(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.

(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).

(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
Kazakhstan	21	2000	5	-1	31	35	5	31
Russian Federation	58	2400	32	55	9	13	12	5
TBA level	**50**	**2400**	**29**	**46**	**11**	**15**	**12**	**8**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
Kazakhstan	0	10	18	31	4	1	1
Russian Federation	1	24	-6	-15	1	0	0
TBA level	**1**	**21**	**-3**	**-10**	**2**	**0**	**0**

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Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
Kazakhstan	11	11	60	Aquifer Mostly unconfined, but some parts confined	Sediment - Sand	High Primary porosity fine/ medium sedimentary deposits	No Secondary porosity	300
Russian Federation	12	12	40	Aquifer Mostly unconfined, but some parts confined	Sediment - Sand	High Primary porosity fine/ medium sedimentary deposits	No Secondary porosity	100
TBA level								

* Including aquitards/aquicludes

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Aquifer description

Aquifer geometry

This is a multi-layered system, with 3 major aquifer horizons in Kazakhstan and 4 in the Russian Federation. The average depth to the water table as well as the average depth to the top of the aquifer is is 11m within Kazakhstan and 12m within the Russian Federation. The average total thickness of the aquifer system varies between 60 and 40m within the two countries respectively. The aquifer is mostly unconfined, but some parts are confined.

Hydrogeological aspects

All aquifers are sedimentary, mainly sand and gravel with high primary porosity and no secondary porosity in the upper layer and in the lower levels mainly sandstone and limestone with high primary porosity and no secondary porosity. There is high horizontal connectivity and low vertical connectivity. Average transmissivity is 300 m^2/d in Kazakhstan and 100 m^2/d in the Russian Federation. The average groundwater volume is $71km^3$. The average annual recharge within Kazakhstan is $73Mm^3$/annum.

Linkages with other water system

The predominant source of recharge is precipitation on the aquifer area and the predominant groundwater discharge mechanism is through river base flow and evapotranspiration. Some indication of flow direction on both sides of the Ural River is provided in the Appendix.

Environmental aspects

The natural quality of groundwater in some locations, but over a significant part of the aquifer within Kazakhstan, does not satisfy local drinking water standards with respect to elevated natural salinity, Fe, Mn, and Br. Some pollution is occurring on the Russia part but to date no pollution as yet has been detected on the Kazakhstan part of the TBA. The pollution is mainly from municipalities

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resulting in elevated nitrogen species. No information is available on the occurrence of shallow groundwater and of groundwater dependent ecosystems.

Socio-economic aspects
The mean annual volume of groundwater abstraction in Kazakhstan is 12 Mm^3/annum, mainly for domestic use and in Russia it is 400 Mm^3/annum. There is no data available on groundwater depletion.

Legal and Institutional aspects
There is no Transboundary Agreement in place and although it is reported that in both countries there is no National Institution in place with the appropriate mandate, groundwater abstraction, groundwater quality protection, and drilling control are done according to law/ regulations, and measures are also applied in practice.

Emerging issues
Russia has not provided recharge figures, but the abstraction in Russia is high and could be of the order of mean annual recharge. No groundwater development is presently taking place close to the border, which if developed could result in a cross-border issue. Groundwater use and quality should be monitored by both countries and attrition should be given to a bilateral agreement.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Dmitrii Plaksin		Kyrgyzstan	plaksind@ya.ru	Regional coordinator
Lucila Candela	Universidad Politécnica de Catalunya	Spain	Lucila.Candela@upc.edu	Regional coordinator
Aleksandr Kuchin	Hydrogeological research and design company "KazHYDEC" Ltd.	Kazakhstan	agkuchin@gmail.com	Contributing national expert
Oleg Podolny	Hydrogeological research and design company "KazHYDEC" Ltd.	Kazakhstan	podolnyo@mail.ru	Lead National Expert
Boris Korolev	Federal state unitary geological organization "Hydrospecialgeology"	Russia	korolyev@mail.ru	Contributing national expert

Considerations and recommendations

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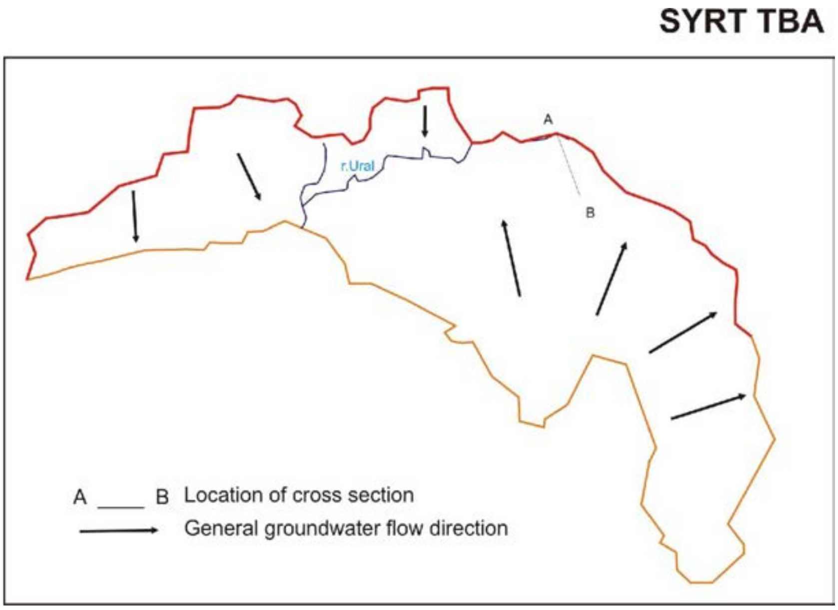
AS11 - Syrt

Appendix: AS11



Indicating Syrt Groundwater flow directions

Colophon

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- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate

AS11 - Syrt

zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: December 2015

AS74 - Tacheng Basin / Alakol

Geography

Total area TBA (km^2): 34 000

No. countries sharing: 2

Countries sharing: Kazakhstan, China

Population: 320 000

Climate Zone: Semi-arid

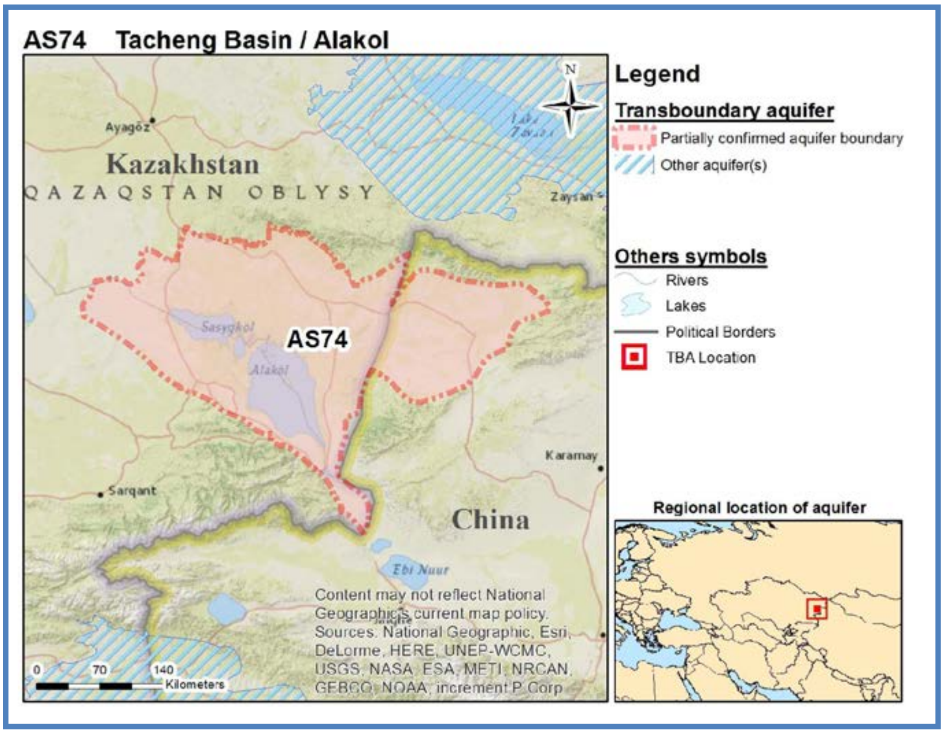
Rainfall (mm/yr): 290

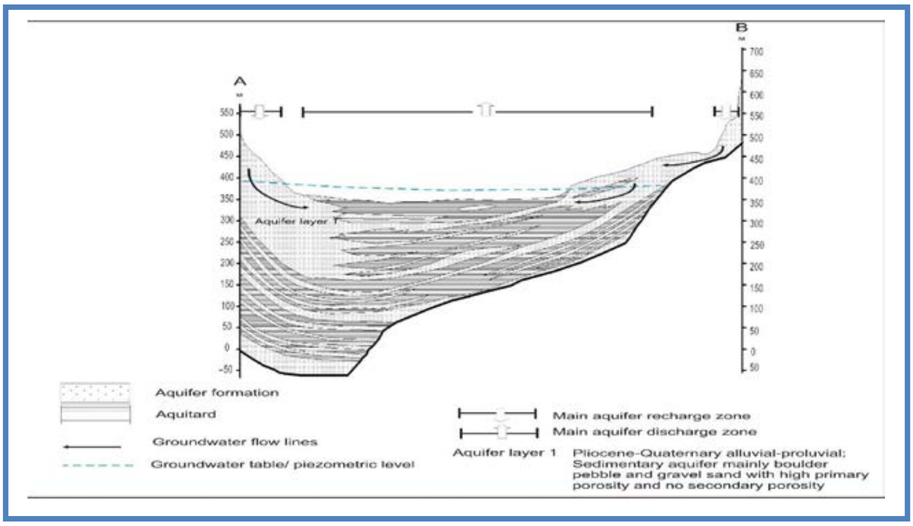
Hydrogeology

Aquifer type: Single to multi-layered system

Degree of confinement: Confined to Unconfined

Main Lithology: Sediment – sand and gravel





Geological cross-section along part of the Tacheng Basin / Alakol showing the main recharge and discharge zones

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS74 - Tacheng Basin / Alakol

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
China	<1	5	100	50	2500	A	24	100	A	
Kazakhstan	35	7100			0		5	<5	D	
TBA level	**26**	**2900**					**9**	**<5**	**E**	

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).
(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.
(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).
(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.
(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).
(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).
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TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
China	240	11 000	6	22	11	15	11	5
Kazakhstan	210	42 000	0	-5	7	36	6	8
TBA level	**210**	**24 000**	**5**	**9**	**10**	**28**	**10**	**7**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
China	-1	21	3	-6	21	0	0
Kazakhstan	2	5	15	24	1	0	0
TBA level	**2**	**9**	**9**	**7**	**6**	**0**	**0**

AS74 - Tacheng Basin / Alakol

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Av. Transmissivity (m^2/d)
China	15**	<5**	480	Aquifer Mostly confined, but some parts unconfined	Sediment - Sand	High Primary porosity fine/ medium sedimentary deposits	Secondary porosity: Fractures	2000
Kazakhstan	<5	<5	100	Aquifer Mostly unconfined, but some parts confined	Sediment - Gravel	High Primary porosity fine/ medium sedimentary deposits	No Secondary porosity	580
TBA level								

* Including aquitards/aquicludes
** These values would need revision as a groundwater table lower than depth to top of the aquifer is un-realistic for a confined aquifer.
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Aquifer description

Aquifer geometry

This is a single to multi-layered system that varies from mostly confined to un-confined conditions. The average depth to the water table varies from <5 – 15 m. The average depth to the top of the aquifer is <5 m while the average thickness of the aquifer system varies from 100m within Kazakhstan to 480m within China.

Hydrogeological aspects

The predominant aquifer lithology is sediment – sand and gravel that has a high primary porosity. Within China secondary porosity: fractures also occur. The formation is characterised by a high horizontal and vertical connectivity. The average transmissivity values range from 580 - 2000 m^2/d. The total groundwater volume within the system is 270 km^3. The average recharge into the system, that is 100% through natural recharge, is 910 Mm^3/yr and the aerial extent of the major recharge area is 18 000 km^2.

Linkages with other water systems

The predominant source of recharge is through infiltration from surface water bodies within Kazakhstan and through precipitation over the aquifer area within China. The major discharge mechanism is through outflow into lakes within Kazakhstan and through river base flow within China (see appendix).

Environmental aspects

Besides some natural salinity over parts of the superficial layers no other significant portion of the aquifer is unsuitable for human consumption. No major anthropogenic groundwater pollution has been identified. 40% of the aquifer within Kazakhstan is characterised by shallow groundwater whereas 80% of the TBA part in China has reported to be covered with groundwater dependent

AS74 - Tacheng Basin / Alakol

ecosystems. However, these groundwater dependent ecosystems may not be all associated with the transboundary aquifer, i.e. they may rely on local national aquifers.

Socio-economic aspects

A total of 3.8 Mm^3 of water was abstracted from the system during 2010. A total amount of 2 Mm^3 of fresh water was abstracted over the aquifer area within China for the same year.

Legal and Institutional aspects

The information on agreements and institutions is not consistent. China makes mention of a signed Bilateral Agreement with full scope, whereas Kazakhstan reports that there is no Agreement in place. China reports that a Transboundary Institute with full mandate and capacity exists, whereas Kazakhstan reports that not even a National Institute with a groundwater mandate currently exists. However, groundwater abstraction is controlled through law/ regulations and measures are also applied in practice in Kazakhstan.

Emerging Issues

The Transboundary Agreement must be reviewed and adapted for application within both countries. The Institutional setup within Kazakhstan must be assessed with a view to possible assistance in this regard.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Sangam Shresta	Asian Institute of Technology	Thailand	sangamshrestha@gmail.com	Regional coordinator
Yao Li	China University of Gesciences, Bejing	China	ly2752@163.com	Contributing national expert
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Zaisheng Han	China University of Gesciences, Bejing	China	hanzsh@hotmail.com	Lead National Expert
Aleksandr Kuchin	Hydrogeological research and design company "KazHYDEC" Ltd.	Kazakhstan	agkuchin@gmail.com	Contributing national expert
Oleg Podolny	Hydrogeological research and design company "KazHYDEC" Ltd.	Kazakhstan	podolnyo@mail.ru	Lead National Expert

Considerations and recommendations

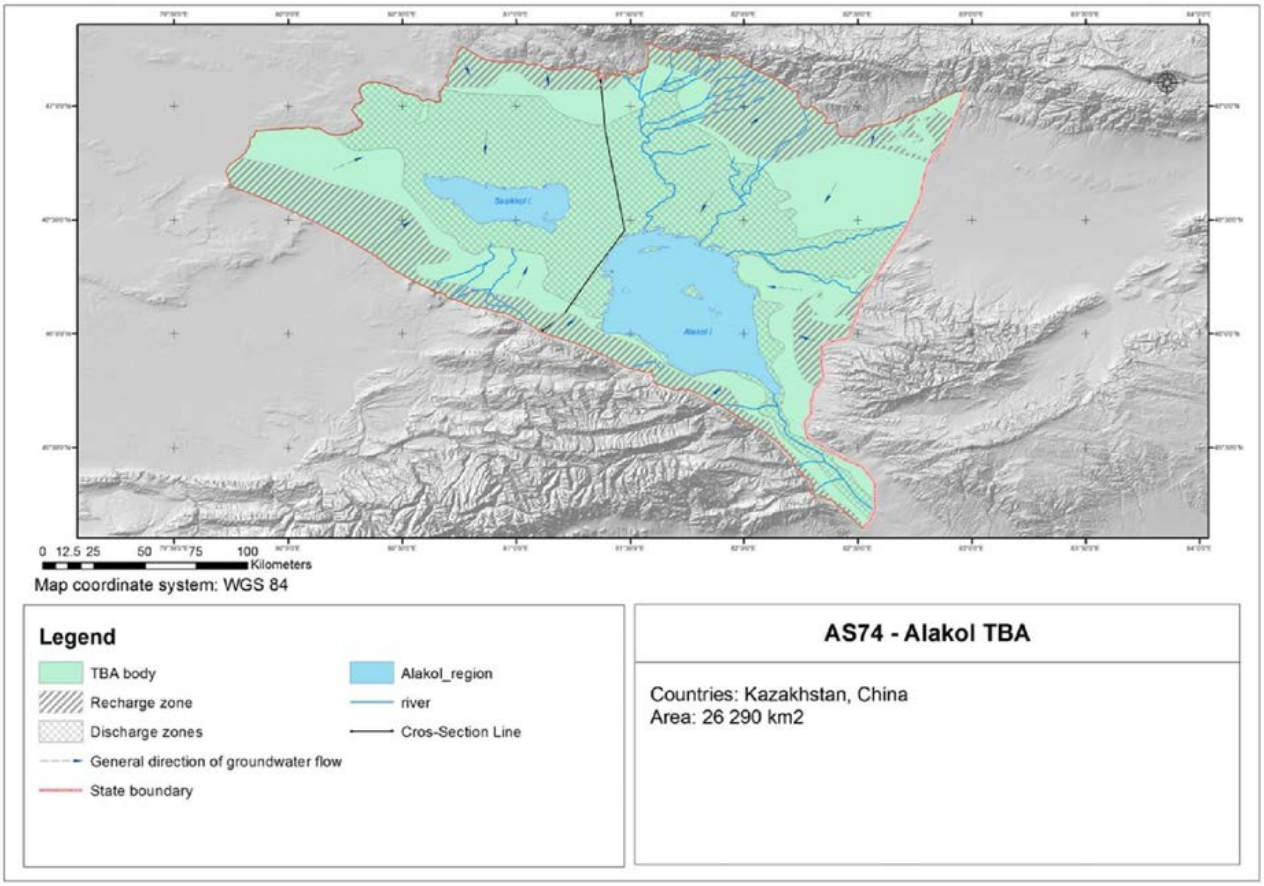
Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

Both transboundary countries have provided adequate technical information, allowing for the calculation of some of the indicators at transboundary level. The inconsistent legal/institutional information indicates that transboundary cooperation is not yet occurring in practice.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

AS74 - Tacheng Basin / Alakol

Appendix: AS74



Tacheng Basin / Alakol: Groundwater recharge-discharge regime

Colophon

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Request:
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References:
- Population: Population has been calculated based on the aquifer map and grid information on population. Source population data: Center for International Earth Science Information Network - CIESIN - Columbia University, United

AS74 - Tacheng Basin / Alakol

Nations Food and Agriculture Programme - FAO, and Centro Internacional de Agricultura Tropical - CIAT. 2005. Gridded Population of the World, Version 3 (GPWv3): Population Count Grid, Future Estimates. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H42B8VZZ. Accessed Jan 2015.

- Rainfall: Average rainfall per TBA has been calculated based on the aquifer map and grid data for precipitation. Source precipitation data: Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. Grid data download from www.worldclim.org (2015): Data for current conditions (~1950-2000), ESRI grids, 30 arc seconds, Precipitation.
- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: September 2015

Jeff Schmaltz, MODIS Rapid Response Team, NASA/GSFC

AS114 - Yalu River Basin

Geography

Total area TBA (km^2): 21 000

No. countries sharing: 2

Countries sharing: China, Democratic People's Republic of Korea

Population: 3 000 000

Climate Zone: Humid Continental

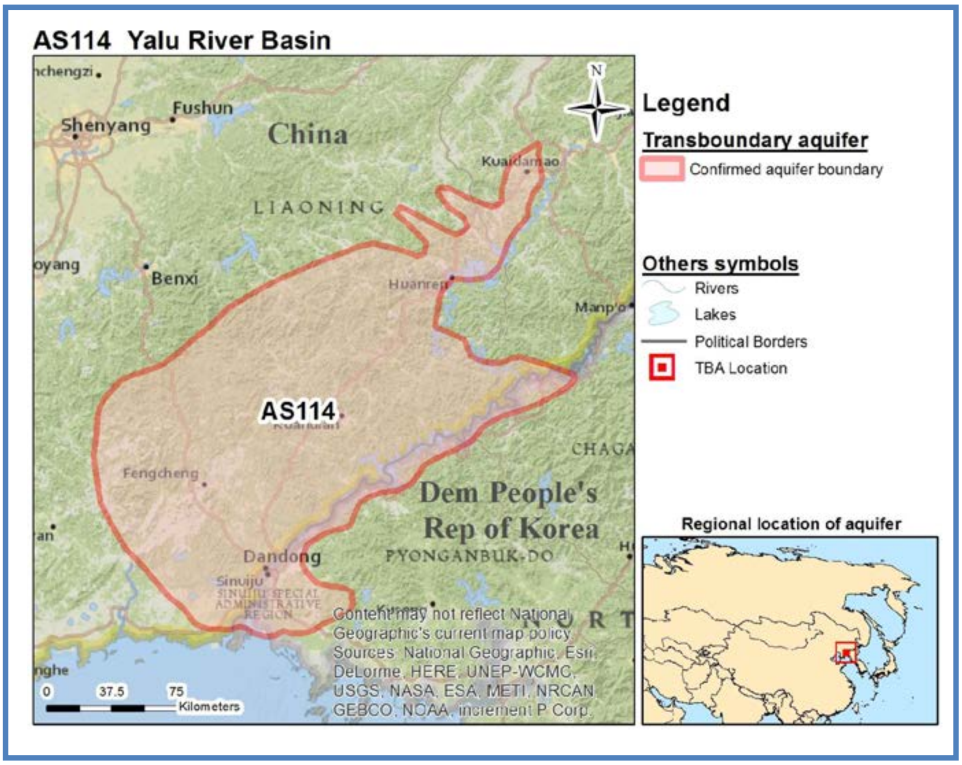
Rainfall (mm/yr): 1000

Hydrogeology

Aquifer type: Data not available

Degree of confinement: Mostly confined, but some parts are unconfined

Main Lithology: Sedimentary rocks -Shale



No cross-section available

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS114 - Yalu River Basin

TWAP Groundwater Indicators from Global Inventory

No data available.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
China	93	640	0	15	33	48	24	41
Dem People's Rep of Korea	120	590	1	13	20	48	15	42
TBA level	**96**	**640**	**0**	**15**	**30**	**48**	**22**	**41**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
China	0	150	3	-6	11	10	12
Dem People's Rep of Korea	1	210	4	-4	13	8	9
TBA level	**0**	**150**	**3**	**-5**	**11**	**9**	**11**

Key parameters table from Global Inventory

No data available.

Aquifer description

Aquifer geometry

The aquifer is mostly confined, but some parts are unconfined. The average depth to the top of the aquifer is 8 m while the average thickness of the aquifer system is 220 m.

Hydrogeological aspects

The predominant aquifer lithology is sedimentary rocks - shale that has a high primary porosity. The average transmissivity value is 1200 m^2/d. The total groundwater volume is 16 km^3. The average recharge into the system is 18 Mm^3/yr. From the groundwater monitoring there are indications of groundwater depletion, but the information in this regard must be reviewed.

Linkages with other water systems

No linkages were recorded.

Environmental aspects

The entire natural water within the aquifer is suitable for human consumption. There is no data available with regard to the current status of anthropogenic groundwater pollution and with regard to shallow groundwater over the aquifer area.

AS86 - Yalu River Valley

Considerations and recommendations

Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

Only 1 of the 2 TBA countries have provided information. Information was adequate to describe the aquifer in general terms. Quantitative information was also available on a national level and this was sufficient to calculate most of the indicators.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

Colophon

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- All other data: TWAP Groundwater (2015).

Version: May 2017

AS114 - Yalu River Basin

Socio-economic aspects

A total amount of 3 Mm^3 of groundwater was abstracted from the system during 2010.

Legal and Institutional aspects

There is a signed Bilateral Agreement with full scope. A dedicated Transboundary Institution exists with a full mandate and capacity.

Emerging Issues

None identified.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Sangam Shresta	Asian Institute of Technology	Thailand	sangamshrestha@gmail.com	Regional coordinator

Considerations and recommendations

Request:

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- All other data: TWAP Groundwater (2015).

Version: October 2015

AS86 - Yalu River Valley

Geography

Total area TBA (km^2): 15 000

No. countries sharing: 2

Countries sharing: China, Democratic People's Republic of Korea

Population: 760 000

Climate Zone: Humid Continental

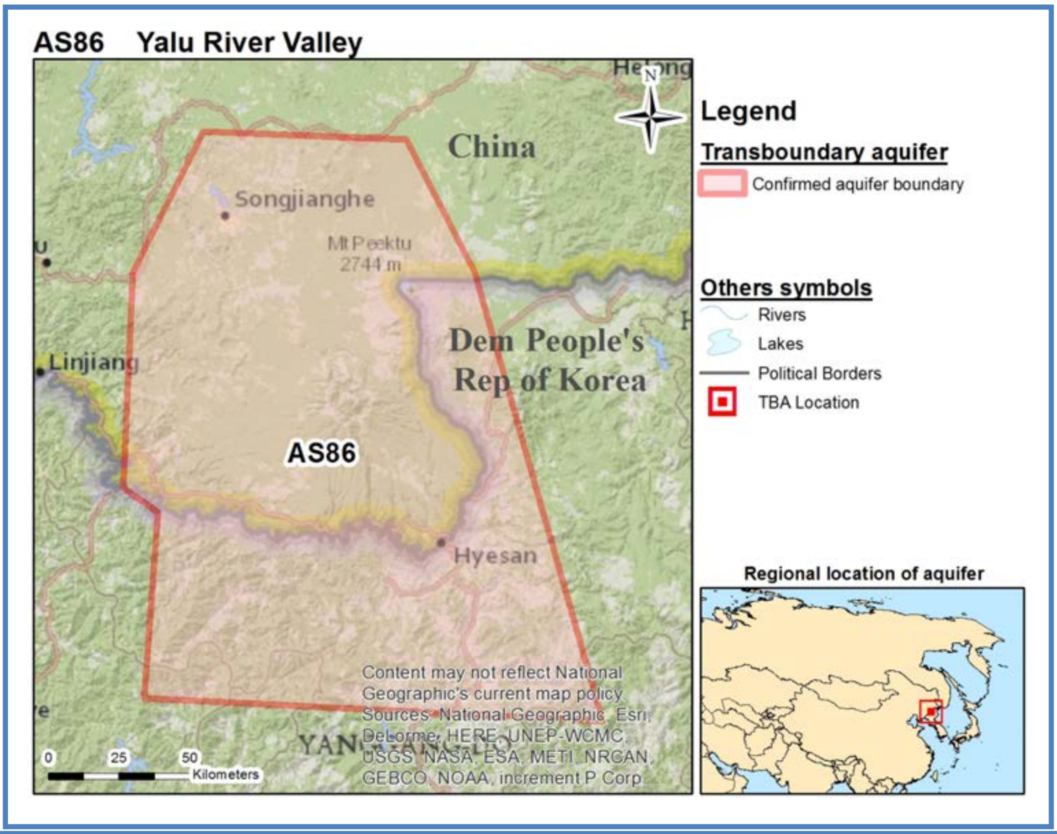
Rainfall (mm/yr): 810

Hydrogeology

Aquifer type: Multiple layered hydraulically connected

Degree of confinement: Aquifer mostly confined, but some parts unconfined

Main Lithology: Data not available



No Cross-section was provided

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS86 - Yalu River Valley

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
China	<1	<1	100	50	3700		42	>1000	A	A
Dem People's Rep of Korea							64			
TBA level							**52**			

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).

(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.

(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).

(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.

(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).

(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
China	20	8	220	Aquifer mostly confined, but some parts unconfined		High primary porosity fine/ medium sedimentary deposits	Secondary porosity: Dissolution	1200
Dem People's Rep of Korea								
TBA level								

* Including aquitards/aquicludes

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

AS86 - Yalu River Valley

Aquifer description

Aquifer geometry

The information provided within this brief refers solely to the China part of the TBA. This is a multiple-layered hydraulically connected system that is mostly confined, but some parts are unconfined. The average depth to the water table is 20 m. The average depth to the top of the aquifer is 8 m while the average thickness of the aquifer system is 220 m.

Hydrogeological aspects

The predominant aquifer lithology is characterized by a high primary porosity with secondary porosity: dissolution. Furthermore it has a high horizontal and vertical connectivity. The average transmissivity value is 1200 m^2/d and the total groundwater volume is 16 km^3. The average recharge into the system is 18 Mm^3/yr over a recharge area of 12 000km^2. There is a certain amount of groundwater depletion that is occurring but the amount will have to be reviewed.

Linkages with other water systems

The predominant source of recharge is through precipitation over the aquifer area. The predominant discharge mechanism is through river base flow.

Environmental aspects

With regard to natural water quality besides some elevated salinity levels within the superficial layers the entire aquifer seems to be suitable for human consumption. Furthermore no anthropogenic pollution has been detected. Around 10 % of the area contains shallow groundwater while around 80 % of the area is covered with groundwater dependent ecosystems.

Socio-economic aspects

A total amount of 3 Mm^3 of groundwater was abstracted from the system during 2010. The total amount of fresh water that was abstracted over the aquifer area was 6 Mm^3.

Legal and Institutional aspects

China reports on a signed Agreement with full Scope. Furthermore accoding to China there is a dedicated Transboundary Institute in place with a full mandate and capacity.

Emerging Issues

The status of Transboundary Aquifer agreement / management within the Democratic People's Republic of Korea should be reviewed.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Sangam Shresta	Asian Institute of Technology	Thailand	sangamshrestha@gmail.com	Regional coordinator
Yao Li	China University of Gesciences, Bejing	China	ly2752@163.com	Contributing national expert
Jing He	China University of Gesciences, Bejing	China	hejing121486@126.com	Contributing national expert
Liyan Yue	China University of Gesciences, Bejing	China	yueliyan00120@126.com	Contributing national expert
Zaisheng Han	China University of Gesciences, Bejing	China	hanzsh@hotmail.com	Lead National Expert

AS77 – Yenisei Upstream

Geography

Total area TBA (km^2): 130 000

No. countries sharing: 2

Countries sharing: Mongolia, Russia

Population: 150 000

Climate Zone: Semi-arid

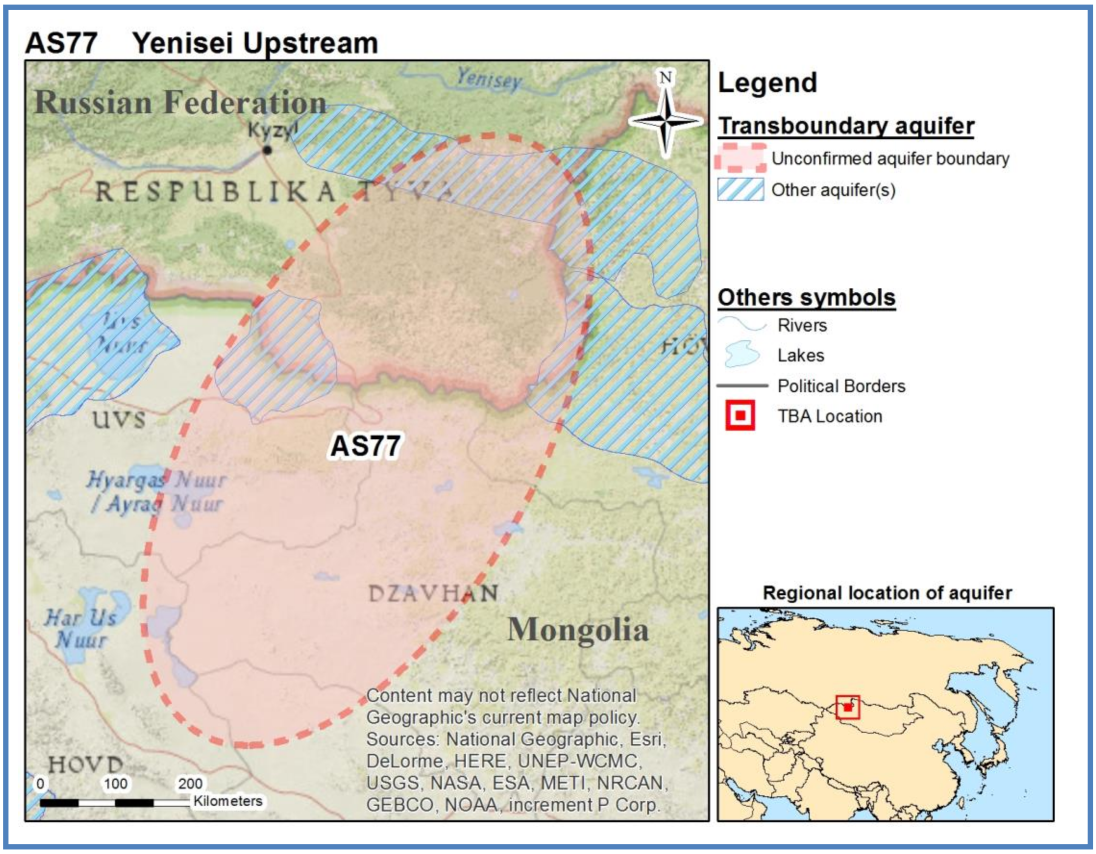
Rainfall (mm/yr): 230

Hydrogeology

Aquifer type: Data not available

Degree of confinement: Data not available

Main Lithology: Data not available



No cross-section available

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS77 – Yenisei Upstream

TWAP Groundwater Indicators from Global Inventory

No data available.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
Mongolia	82	70 000	-22	-33	12	79	26	0
Russian Federation	7	9200	14	26	19	20	17	80
TBA level	**57**	**55 000**	**-16**	**-25**	**12**	**49**	**26**	**0**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
Mongolia	0	1	30	51	<1	0	0
Russian Federation	0	1	-2	-8	<1	0	0
TBA level	**0**	**1**	**21**	**36**	**<1**	**0**	**0**

Key parameters table from Global Inventory

No data available.

Aquifer description

No data available.

Contributors to Global Inventory

No contributions.

Considerations and recommendations

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AS77 – Yenisei Upstream

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- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: April 2017

AS105 - Zeya River Basin

Geography

Total area TBA (km^2): 77 100

No. countries sharing: 2

Countries sharing: China, Russia

Population: 680 000

Climate Zone: Humid Continental

Rainfall (mm/yr): 580

Hydrogeology

Aquifer type: Data not available

Degree of confinement: Data not available

Main Lithology: Data not available

No cross-section available

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate.

AS105 - Zeya River Basin

TWAP Groundwater Indicators from Global Inventory

No data available.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita: Current state (m^3/y/capita)	Renewable groundwater per capita: Projection 2030 (% change to current state)	Renewable groundwater per capita: Projection 2050 (% change to current state)	Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
China	67	7300	12	22	25	37	46	6
Russian Federation	79	8800	18	30	28	33	35	21
TBA level	**77**	**8500**	**17**	**29**	**27**	**34**	**42**	**20**

	Groundwater depletion (mm/y)	Population density: Current state (Persons/km2)	Population density: Projection 2030 (% change to current state)	Population density: Projection 2050 (% change to current state)	Groundwater development stress: Current state (%)	Groundwater development stress: Projection 2030 (% point change to current state)	Groundwater development stress: Projection 2050 (% point change to current state)
China	-1	9	2	-8	1	0	0
Russian Federation	-1	9	-5	-14	1	0	0
TBA level	**-1**	**9**	**-4**	**-13**	**1**	**0**	**0**

Key parameters table from Global Inventory

No data available.

Aquifer description

No data available.

Contributors to Global Inventory

No contributions.

Considerations and recommendations

Request:
If you have data or information about this transboundary aquifer that can improve the quality of this information sheet and the underlying database, please contact us via email at info@un-igrac.org. If appropriate, the information will be uploaded to the database of transboundary aquifers and will also be used in new versions of this information sheet.

AS105 - Zeya River Basin

Colophon

This Transboundary Aquifers information sheet has been produced as part of the Groundwater Component of the GEF Transboundary Water Assessment Programme (GEF TWAP). **GEF TWAP** is the first truly global comparative assessment of transboundary groundwater, lakes, rivers, large marine ecosystems and the open ocean. More information on TWAP can be found on: www.geftwap.org . **The Groundwater component** of TWAP carried out a global comparison of 199 transboundary aquifers and the groundwater systems of 41 Small Island Developing States. The data used to compile this transboundary aquifer information sheet has been made available by national and regional experts from countries involved in the TWAP Groundwater project. For aquifers larger than 20 000 km2 and which are not overlapping, additional data are available from modelling done by the Goethe University Frankfurt (Germany) as part of TWAP Groundwater. All data were compiled by UNESCO-IHP and the International Groundwater Resources Assessment Centre (IGRAC – UNESCO Category II Institute). Values given in the fact-sheet represent an approximate guide only and should not replace data obtained from recent local assessments. The editors of this information sheet are not responsible for the quality of the data.

For more information on TWAP Groundwater and for more data, please have a look at the TWAP Groundwater Information Management System which is accessible via www.twap.isarm.org or www.un-igrac.org.

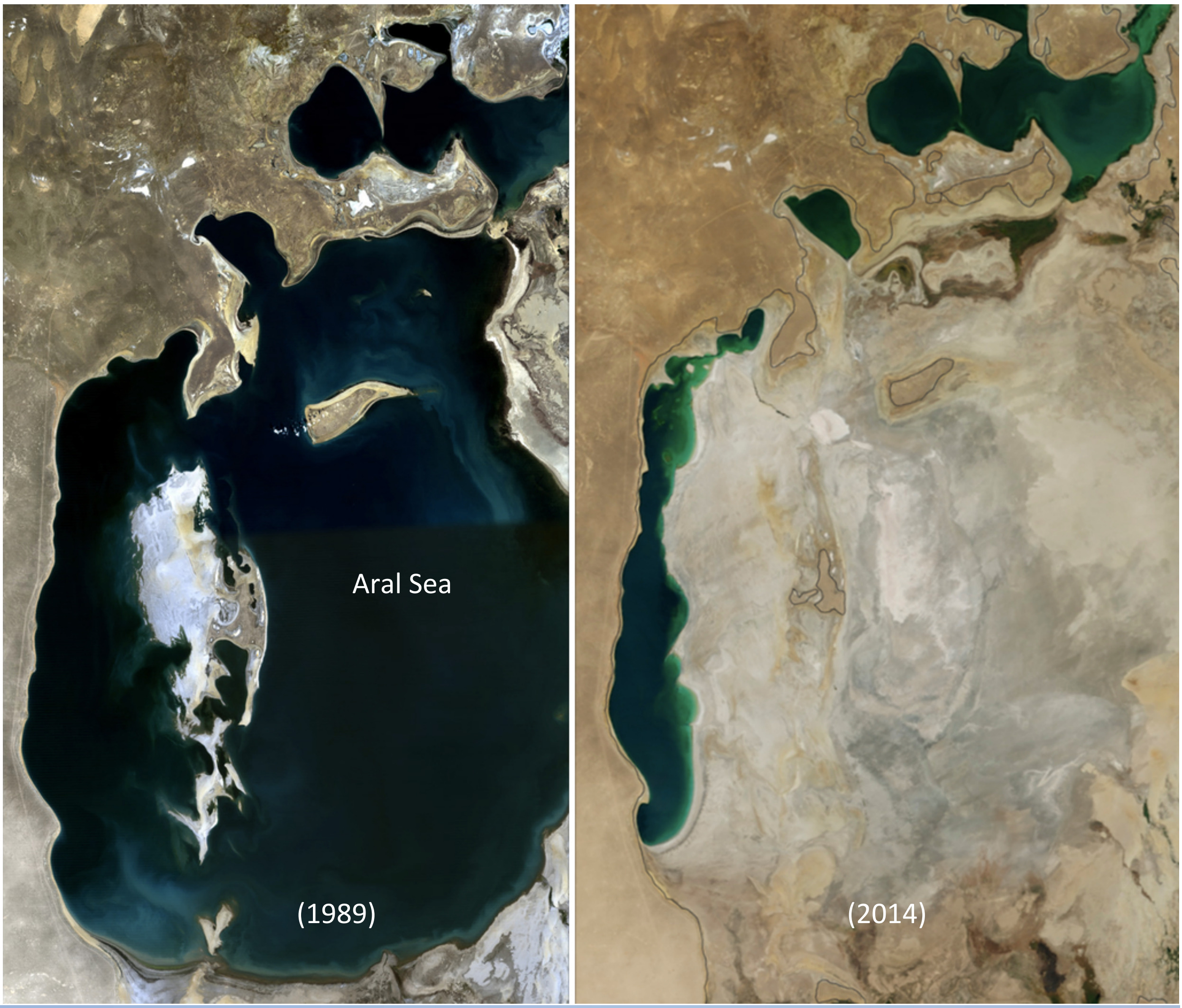
References:

- Population: Population has been calculated based on the aquifer map and grid information on population. Source population data: Center for International Earth Science Information Network - CIESIN - Columbia University, United Nations Food and Agriculture Programme - FAO, and Centro Internacional de Agricultura Tropical - CIAT. 2005. Gridded Population of the World, Version 3 (GPWv3): Population Count Grid, Future Estimates. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H42B8VZZ. Accessed Jan 2015.
- Rainfall: Average rainfall per TBA has been calculated based on the aquifer map and grid data for precipitation. Source precipitation data: Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. Grid data download from www.worldclim.org (2015): Data for current conditions (~1950-2000), ESRI grids, 30 arc seconds, Precipitation.
- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: October 2015

Transboundary Lakes/ Reservoirs of Eastern & Central Asia

1. Aral
2. Caspian Sea
3. Sarygamysh
4. Shardara/ Kara-Kul



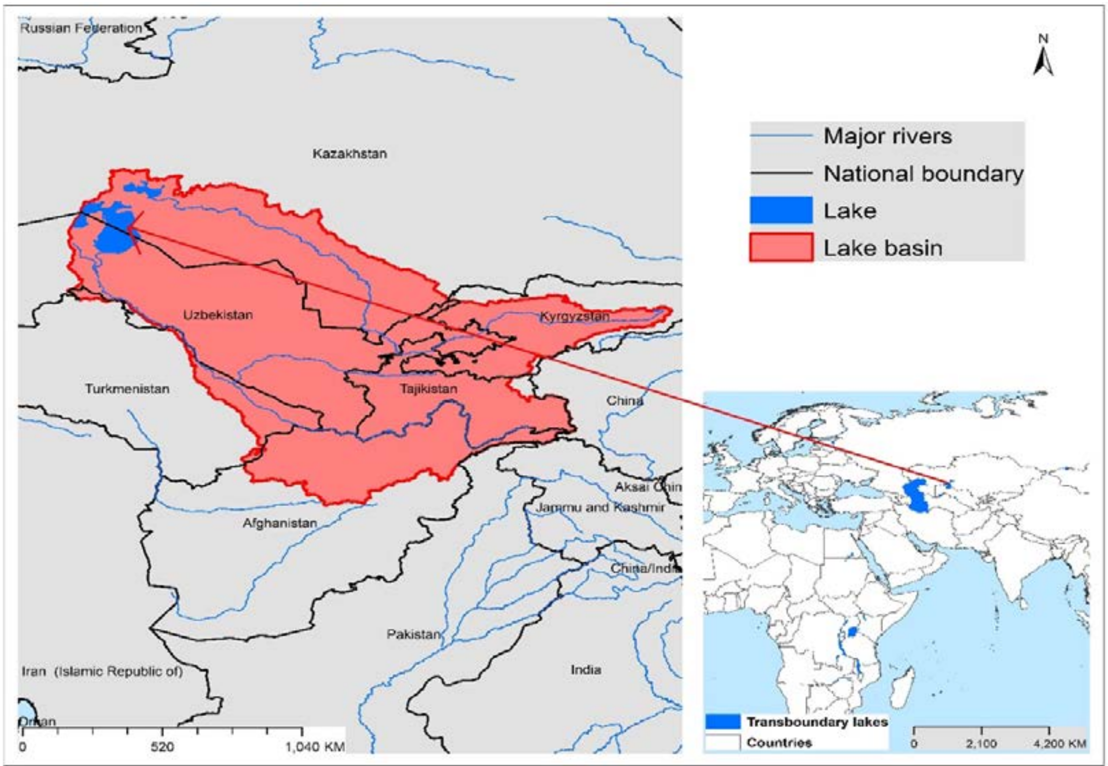
NASA, collage by Producercunningham

Abandoned ship in the Aral Sea, Aral, Kazakhstan (2004)

Staecker

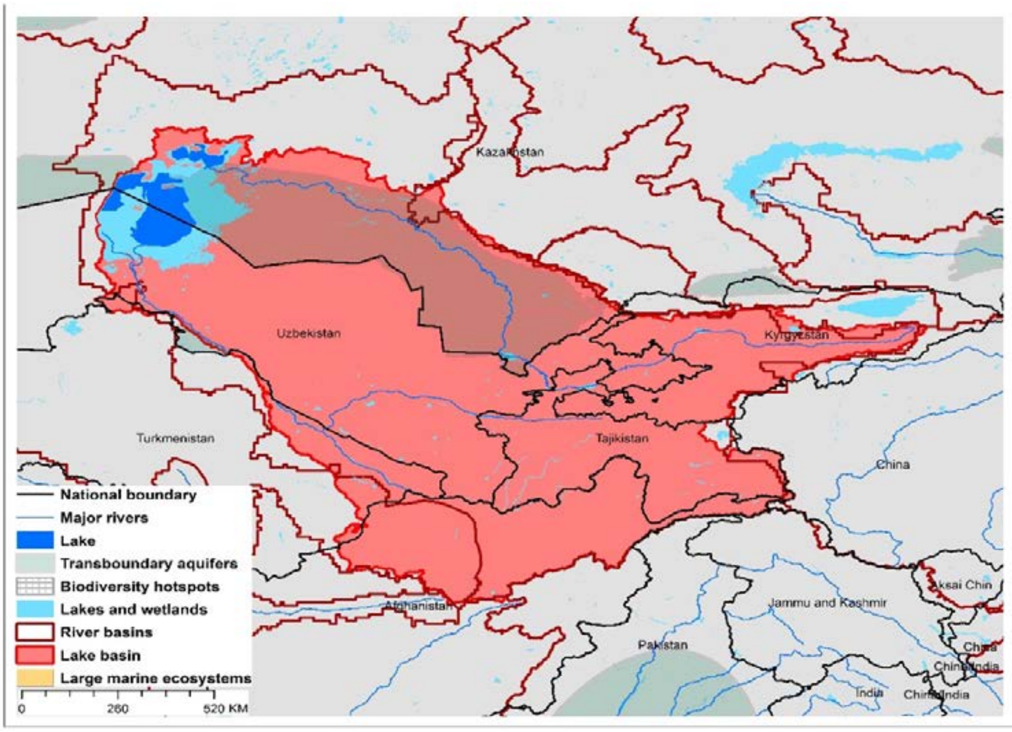
Aral Sea — Geographic Information

The Aral Sea, a terminal lake and once one of the four largest lakes in the world, is a dramatic example of poor natural resource management, experiencing an extreme loss of water from poor policies and excessive agricultural irrigation practices beginning in the 1960s. Described as one of the world's worst environmental disasters, its prosperous fishing industry was essentially destroyed, with resulting unemployment and economic hardships. The Aral Sea region is also heavily polluted. The lake declined to 10% of its original size, splitting into the north Aral Sea, eastern and western basins of the previously larger South Aral Sea, and a smaller lake between the North and South Aral Seas by 2007. The eastern basin completely dried up in 2014. Efforts are underway to replenish the North Aral Sea. Construction of a dam has improved the lake level, decreased water salinity, and facilitated a somewhat viable fishery. Although the lake has been the subject of a number of international water treaties, its future nevertheless remains unclear. It has already received GEF funding, but is again becoming a subject for possible GEF-catalyzed management interventions, which would require due elaboration within an appropriately-established international consultative process.

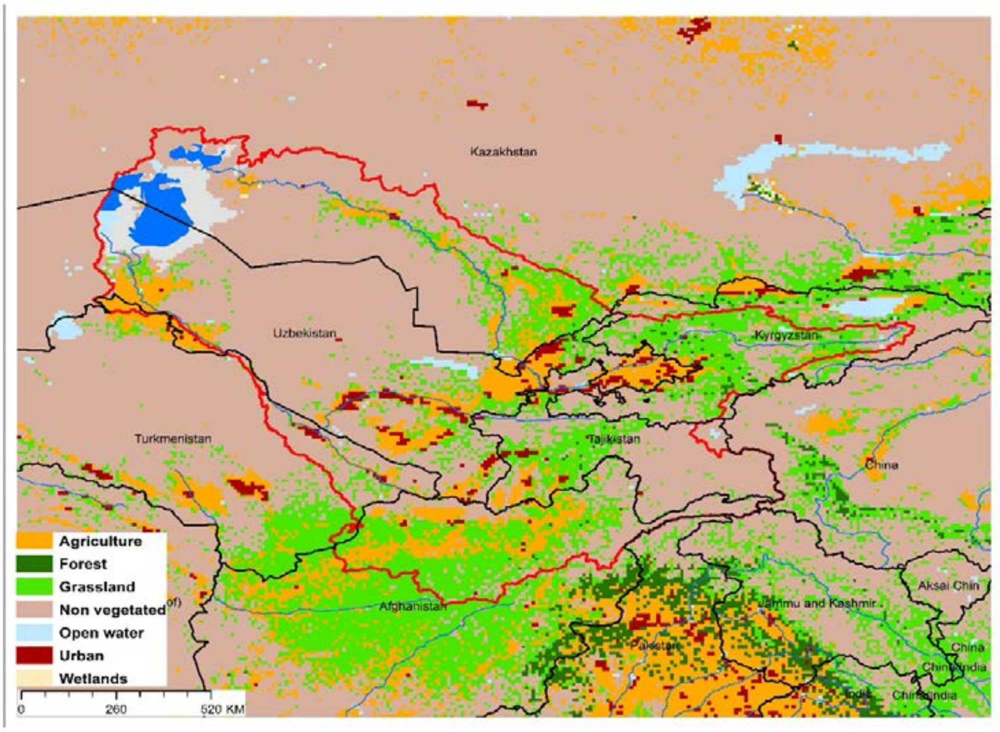


TWAP Regional Designation	Eastern & Central Asia		**Lake Basin Population (2010)**	48,540,276
River Basin	Aral (endorheic)		**Lake Basin Population Density (2010; # km^{-2})**	30.5
Riparian Countries	Kazakhstan, Uzbekistan		**Average Basin Precipitation (mm yr^{-1})**	309.4
Basin Area (km^2)	1,092,375		**Shoreline Length (km)**	1,784
Lake Area (km^2)	23,919		**Human Development Index (HDI)**	0.60
Lake Area:Lake Basin Ratio	0.022		**International Treaties/Agreements Identifying Lake**	Yes

Aral Sea Basin Characteristics



(a) Aral Sea basin and associated transboundary water systems



(b) Aral Sea basin land use

Aral Sea Threat Ranking

A serious lack of global-scale uniform data on the TWAP transboundary in-lake conditions required their potential threat risks be estimated on the basis of the characteristics of their drainage basins, rather than in-lake conditions. Using basin characteristics to rank transboundary lake threats precludes consideration of the unique features that can buffer their in-lake responses to basin-derived disturbances, including an integrating nature for all inputs, long water retention times, and complex, non-linear response dynamics.

The lake threat ranks were calculated with a spreadsheet-based interactive scenario analysis program, incorporating data and information about the nature and magnitude of their basin-derived stresses, and their possible impacts on the sustainability of their ecosystem services. These descriptive data for Aral Sea and the other transboundary lakes included lake and basin areas, population numbers and densities, areal extent of basin stressors on the lake, data grid size, and other components considered important from the perspective of the user of the data results. The scenario analysis program also provides a means to define the appropriate context and preconditions for interpreting the ranking results.

The Aral Sea threat ranks are expressed in terms of the Adjusted Human Water Security (Adj-HWS) threats, Reverse Biodiversity (RvBD) threats, and the Human Development Index (HDI) score, as well as combinations of these indices. However, it is emphasized that, being based on specific characteristics and assumptions regarding Aral Sea and its basin characteristics, the calculated threat scores represent only one possible set of lake threat rankings. Defining the appropriate context and preconditions for interpreting the lake rankings remains an important responsibility of those using the threat ranking results, including lake managers and decision-makers.

Table 1. Aral Sea Relative Threat Ranks, Based on Adjusted Human Water Security (Adj-HWS) and Reverse Biodiversity Threats, and Human Development Index (HDI) Score

(Estimated risks: red – highest; orange – moderately high; yellow – medium; green – moderately low; blue – low)

Adjusted Human Water Security (Adj-HWS) Threat Score	Relative Adj-HWS Threat Rank		Reverse Biodiversity (RvBD) Threat Score	Relative RvBD Threat Rank		Human Development Index (HDI) Score	Relative HDI Rank
0.84	26		0.72	5		0.60	26

It is emphasized that the Aral Sea rankings above are discussed here within the context of the management and decision-making process, rather than as strict numerical ranks. Based on its geographic, population and socioeconomic assumptions used in the scenario analysis program, the calculated Adj-HWS score for Aral Sea indicates a medium threat rank compared to other priority transboundary lakes.

The Reverse Biodiversity (RvBD) for Aral Sea, which is meant to describe its biodiversity sensitivity to basin-derived degradation, places the lake in a high threat rank, compared to the other transboundary lakes. Management interventions directed to improving the biodiversity status must be viewed with caution, however, since we lack sufficient knowledge and experience to accurately predict the ultimate impacts of biodiversity manipulations and preservation efforts. Further, the RvBD scores indicate the relative sensitivity of a lake basin to human activities, and high threat scores *per se* do not necessarily justify management interventions. Such interventions may actually increase biodiversity degradation, noting that many developed countries have already fundamentally degraded their biodiversity because of economic development activities. Thus, activities undertaken to address the Adj-HWS threats may actually degrade the biodiversity status and resources, even if the health and socioeconomic conditions of the lake basin stakeholders are improved as a result of better conditions, thereby increasing stakeholder resource consumption.

The relative Human Development Index (HDI) places the Aral Sea basin in a medium threat rank in regard to its health, educational and economic conditions.

Table 2. Aral Sea Threat Ranks, Based on Multiple Ranking Criteria

(Scores for Adj-HWS, RvBD and HDI ranks are presented in Table 1; the ranks may differ in some cases because of rounding of tied threat scores; Estimated risks: red – highest; orange – moderately high; yellow – medium;
green – moderately low; blue – low)

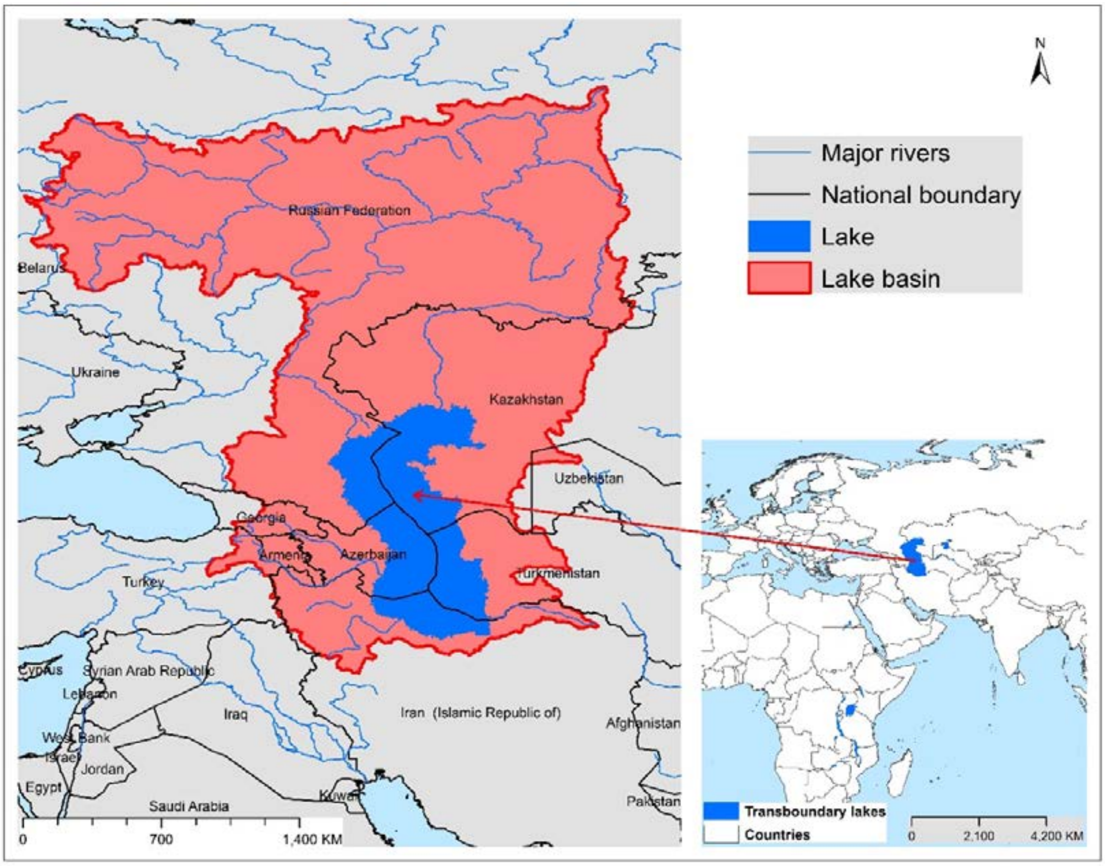
Adj-HWS Rank	HDI Rank	RvBD Rank		Sum Adj-HWS + RvBD	Relative Threat Rank		Sum Adj-HWS + HDI	Relative Threat Rank		Sum Adj-HWS + RvBD + HDI	Overall Threat Rank
27	26	5		32	13		53	31		58	20

When multiple ranking criteria are considered together in the threat rank calculations, the Adj-HWS and HDI scores considered together place Aral Sea in the lower half of the threat ranks. The relative threat is notably increased when the Adj-HWS and RvBD threats are considered together. Considering all three ranking criteria together, Aral Sea exhibits a moderately high threat ranking.

Interactions between the ranking parameters for Aral Sea indicate differing sensitivity to basin-derived stresses. Identifying potential management interventions needs for Aral Sea must be considered on the basis of educated judgement and accurate representations of its situation. A fundamental question will be how can one decide a given management intervention will produce the greatest benefit(s) for the greatest number of people in the Aral Sea basin? Accurate answers to such questions for Aral Sea, and other transboundary lakes, will require a case-by-case assessment approach that considers the specific lake situation and the anticipated improvements from specific management interventions, as well as interactions with water systems to which the lake is linked.

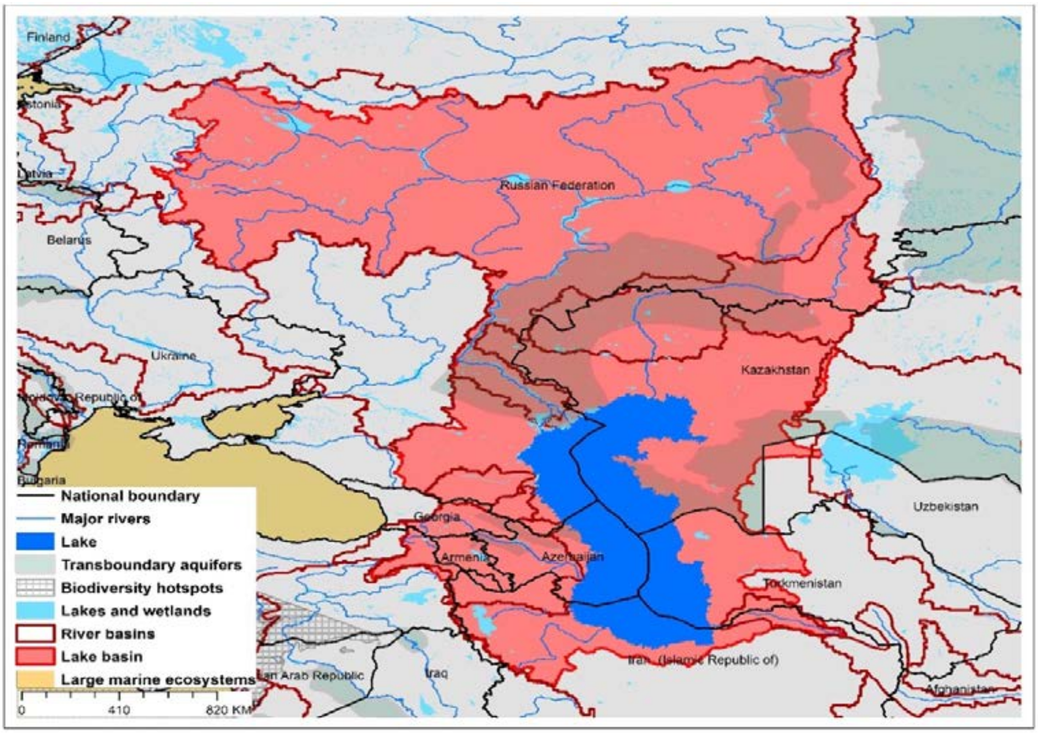
Caspian Sea — Geographic Information

The Caspian Sea, a terminal lake, is the world's largest single enclosed inland waterbody. It also is the largest salt lake in the world, containing about one-third of its inland surface waters, with a mean salinity about one-third of Earth's oceans. The Volga River contributes about 80% of its inflow. The lake has exhibited dramatic water level changes over the centuries synchronized largely with Volga River inflows, and more recently to climate change. The Volga River is thought to be the principal source of transboundary contaminants to the lake. The lake contains a heavily-exploited sturgeon population (caviar source), to the point banning sturgeon fishing has been advocated until the population recovers, although the high caviar prices constrain this goal. Another major environmental concern is oil and natural gas production activities along the lake edges. The lake has already received GEF funding, and consideration of further GEF-catalyzed management interventions requires a review of its GEF status.

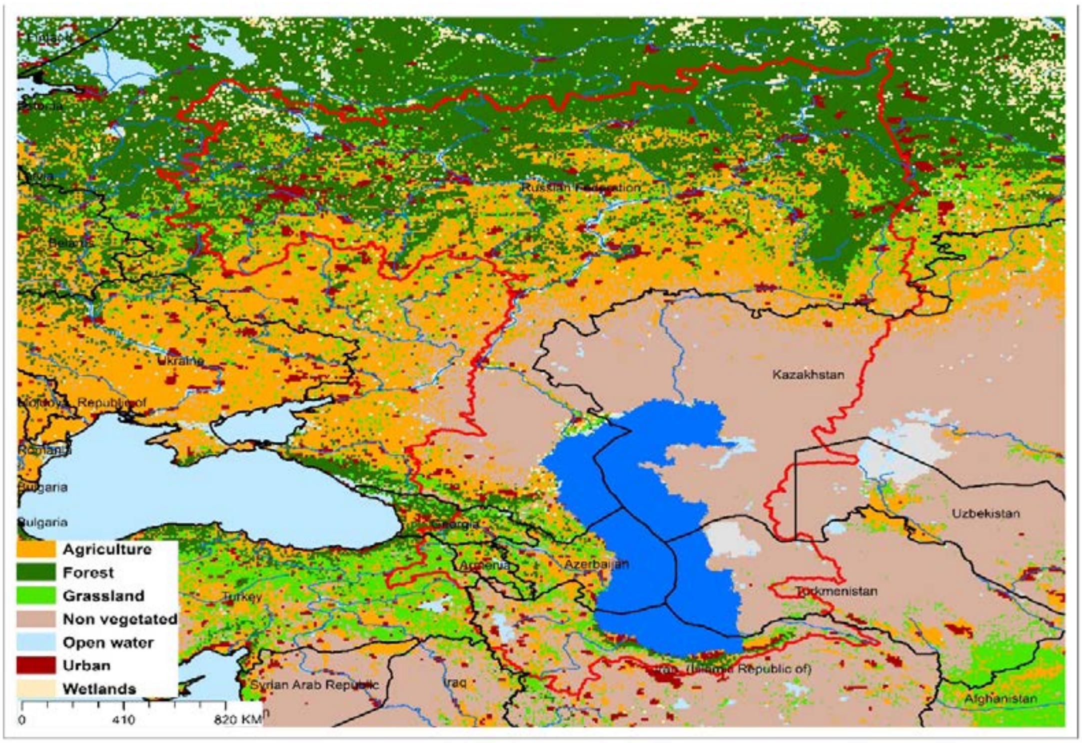


TWAP Regional Designation	Northern Africa & Western Asia; Eastern & Central Asia; Southern Asia; Eastern Europe	**Lake Basin Population (2010)**	105,000,000
River Basin	Caspian (endorheic)	**Lake Basin Population Density (2010; # km^{-2})**	20.1
Riparian Countries	Azerbaijan, Iran, Kazakhstan, Russia	**Average Basin Precipitation (mm yr^{-1})**	448.5
Basin Area (km^2)	3,412,322	**Shoreline Length (km)**	9,042
Lake Area (km^2)	377,543	**Human Development Index (HDI)**	0.77
Lake Area:Lake Basin Ratio	0.117	**International Treaties/Agreements Identifying Lake**	Yes

Caspian Sea Basin Characteristics



(a) Caspian Sea basin and associated transboundary water systems



(b) Caspian Sea basin land use

Caspian Sea Threat Ranking

A serious lack of global-scale uniform data on the TWAP transboundary in-lake conditions required their potential threat risks be estimated on the basis of the characteristics of their drainage basins, rather than in-lake conditions. Using basin characteristics to rank transboundary lake threats precludes consideration of the unique features that can buffer their in-lake responses to basin-derived disturbances, including an integrating nature for all inputs, long water retention times, and complex, non-linear response dynamics.

The lake threat ranks were calculated with a spreadsheet-based interactive scenario analysis program, incorporating data and information about the nature and magnitude of their basin-derived stresses, and their possible impacts on the sustainability of their ecosystem services. These descriptive data for Caspian Sea and the other transboundary lakes included lake and basin areas, population numbers and densities, areal extent of basin stressors on the lake, data grid size, and other components considered important from the perspective of the user of the data results. The scenario analysis program also provides a means to define the appropriate context and preconditions for interpreting the ranking results.

The Caspian Sea threat ranks are expressed in terms of the Adjusted Human Water Security (Adj-HWS) threats, Reverse Biodiversity (RvBD) threats, and the Human Development Index (HDI) score, as well as combinations of these indices. However, it is emphasized that, being based on specific characteristics and assumptions regarding Caspian Sea and its basin characteristics, the calculated threat scores represent only one possible set of lake threat rankings. Defining the appropriate context and preconditions for interpreting the lake rankings remains an important responsibility of those using the threat ranking results, including lake managers and decision-makers.

Table 1. Caspian Sea Relative Threat Ranks, Based on Adjusted Human Water Security (Adj-HWS) and Reverse Biodiversity Threats, and Human Development Index (HDI) Score

(Estimated risks: red – highest; orange – moderately high; yellow – medium; green – moderately low; blue – low)

Adjusted Human Water Security (Adj-HWS) Threat Score	Relative Adj-HWS Threat Rank		Reverse Biodiversity (RvBD) Threat Score	Relative RvBD Threat Rank		Human Development Index (HDI) Score	Relative HDI Rank
0.79	39		0.60	27		0.77	41

It is emphasized that the Caspian Sea rankings above are discussed here within the context of the management and decision-making process, rather than as strict numerical ranks. Based on its geographic, population and socioeconomic assumptions used in the scenario analysis program, the calculated Adj-HWS score for Caspian Sea indicates a moderately low threat rank compared to other priority transboundary lakes.

The Reverse Biodiversity (RvBD) for Caspian Sea, which is meant to describe its biodiversity sensitivity to basin-derived degradation, places the lake in a medium threat rank, compared to the other transboundary lakes. Management interventions directed to improving the biodiversity status must be viewed with caution, however, since we lack sufficient knowledge and experience to accurately predict the ultimate impacts of biodiversity manipulations and preservation efforts. Further, the RvBD scores indicate the relative sensitivity of a lake basin to human activities, and high threat scores *per se* do not necessarily justify management interventions. Such interventions may actually increase biodiversity degradation, noting that many developed countries have already fundamentally degraded their biodiversity because of economic development activities. Thus, activities undertaken to address the Adj-HWS threats may actually degrade the biodiversity status and resources, even if the health and socioeconomic conditions of the lake basin stakeholders are improved as a result of better conditions, thereby increasing stakeholder resource consumption.

The relative Human Development Index (HDI) places the Caspian Sea basin in a moderately low threat rank in regard to its health, educational and economic conditions.

Table 2. Caspian Sea Threat Ranks, Based on Multiple Ranking Criteria

(Scores for Adj-HWS, RvBD and HDI ranks are presented in Table 1; the ranks may differ in some cases because of rounding of tied threat scores; Estimated risks: red – highest; orange – moderately high; yellow – medium;
green – moderately low; blue – low)

Adj-HWS Rank	HDI Rank	RvBD Rank		Sum Adj-HWS + RvBD	Relative Threat Rank		Sum Adj-HWS + HDI	Relative Threat Rank		Sum Adj-HWS + RvBD + HDI	Overall Threat Rank
39	41	27		66	36		80	40		107	38

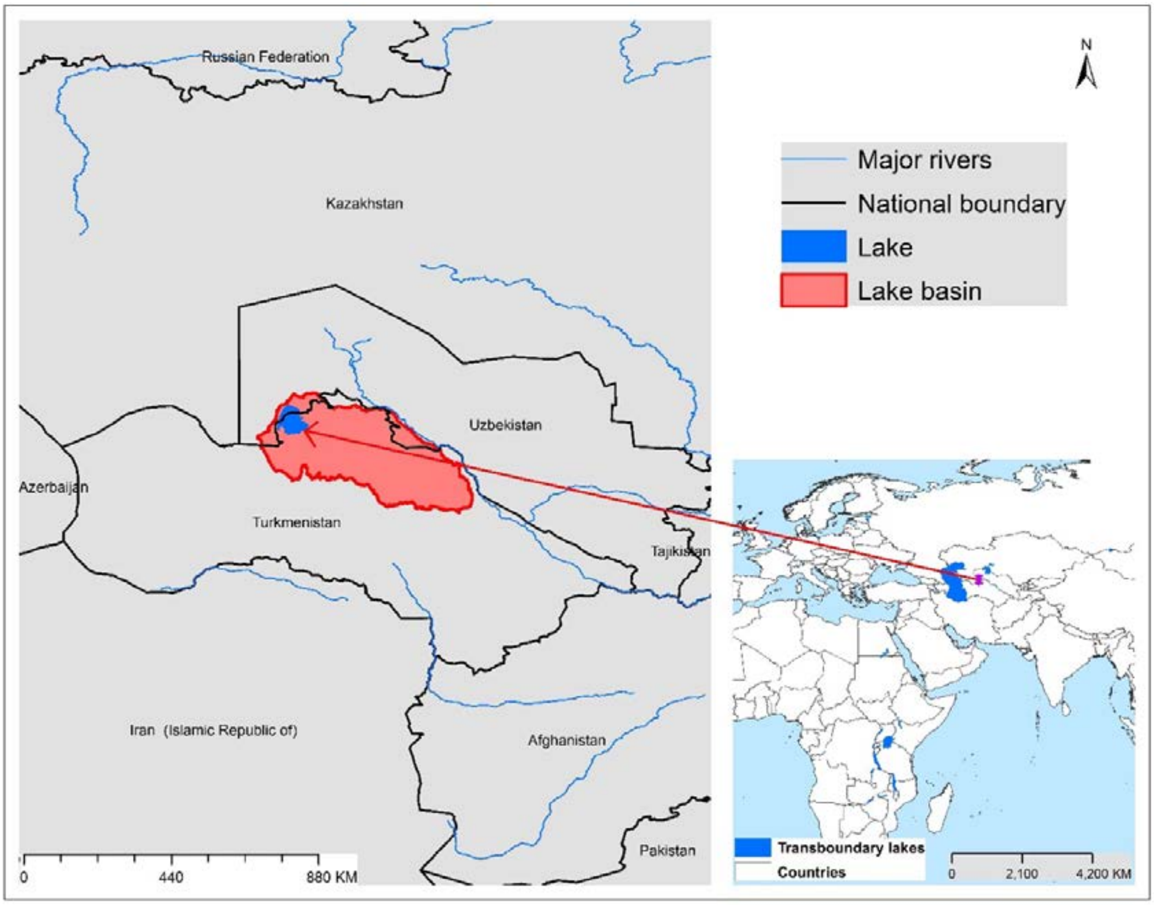
When multiple ranking criteria are considered together in the threat rank calculations, the Adj-HWS and HDI scores considered together place Caspian Sea in the lower quarter of the threat ranks. The relative threat is somewhat increased when the Adj-HWS and RvBD threats are considered together. Considering all three ranking criteria together, Caspian Sea exhibits an overall moderately low threat ranking.

Interactions between the ranking parameters for Caspian Sea indicate differing sensitivity to basin-derived stresses. Identifying potential management interventions needs for Caspian Sea must be considered on the basis of educated judgement and accurate representations of its situation. A fundamental question will be how can one decide a given management intervention will produce the greatest benefit(s) for the greatest number of people in the Caspian Sea basin? Accurate answers to such questions for Caspian Sea, and other transboundary lakes, will require a case-by-case assessment approach that considers the specific lake situation and the anticipated improvements from specific management interventions, as well as interactions with water systems to which the lake is linked.

Lake Sarygamysh

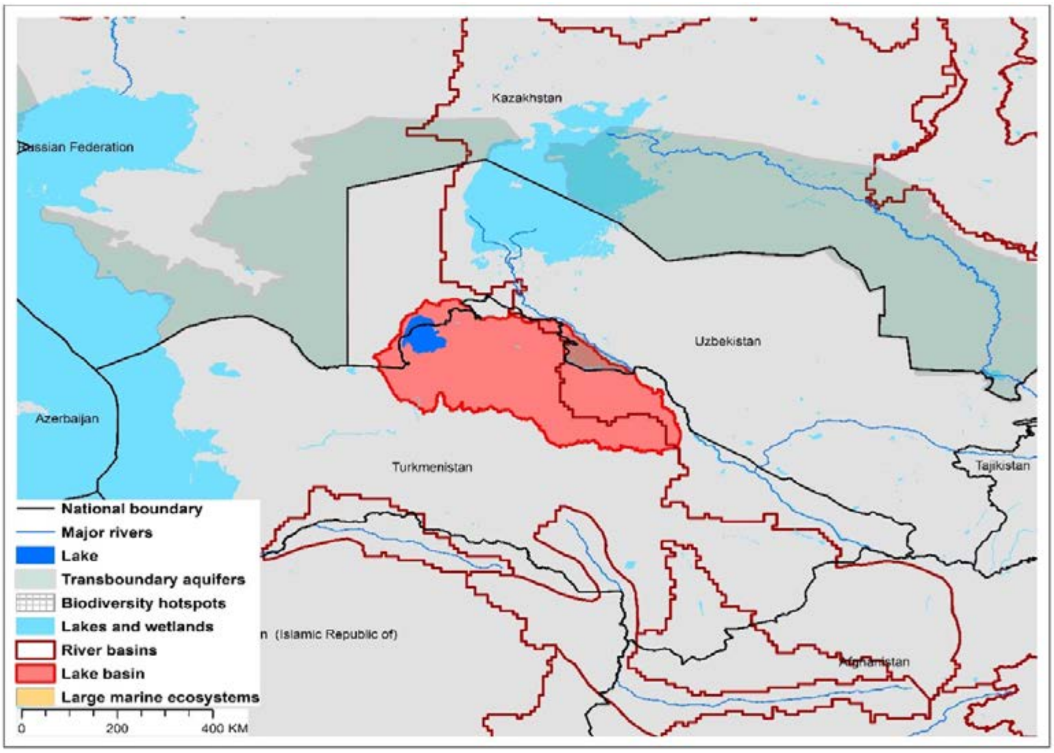
Geographic Information

Sarygamysh Lake is situated in central north Turkmenistan, approximately midway between the Caspian and Aral seas. It was fed up to the 17th Century by a tributary of the Amu Darya River which ultimately drains to the Caspian Sea. Following the earlier diversion of the Amu Darya by the former Soviet Union for irrigation purposes, the lake currently receives runoff water from surrounding irrigation lands, which contain high levels of pesticides, herbicides and heavy. Its situation is closely related to that of the Aral Sea in regard to possible management interventions. The assessment of possible GEF-catalyzed management interventions, therefore, is closely related to the outcome of international discussions of the Aral Sea, if the latter is to be realized.

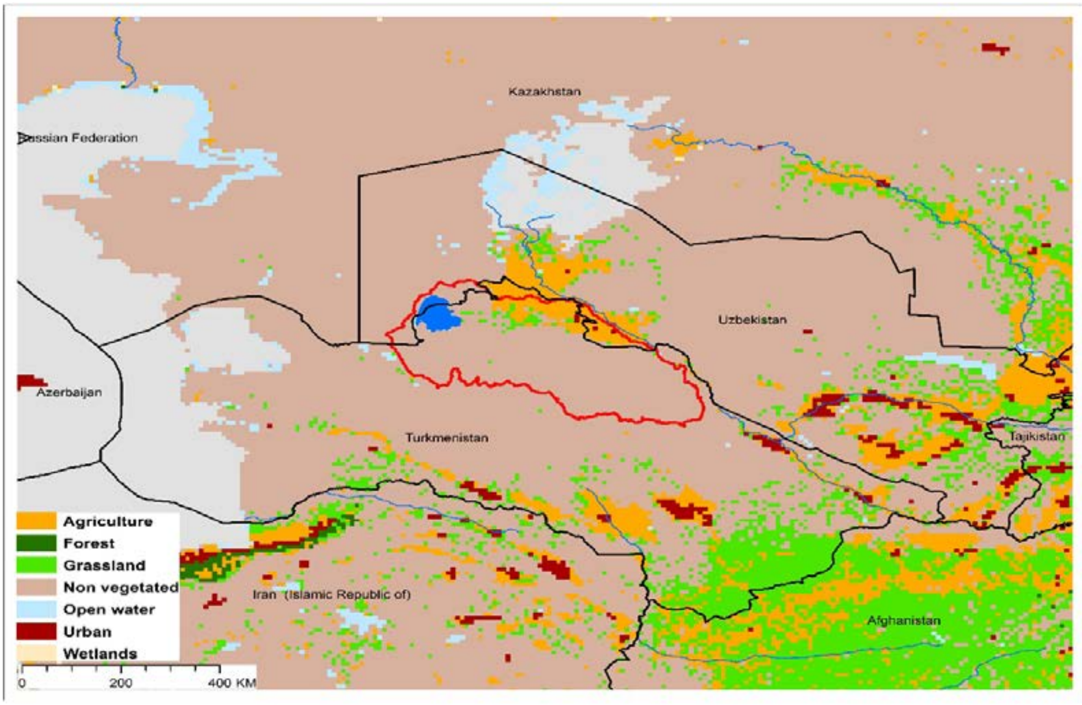


TWAP Regional Designation	Eastern & Central Asia	**Lake Basin Population (2010)**	2,119,732
River Basin	Amu Darya	**Lake Basin Population Density (2010; # km^{-2})**	14.4
Riparian Countries	Turkmenistan, Uzbekistan	**Average Basin Precipitation (mm yr^{-1})**	114.0
Basin Area (km^2)	94,188	**Shoreline Length (km)**	411.0
Lake Area (km^2)	3,778	**Human Development Index (HDI)**	0.67
Lake Area:Lake Basin Ratio	0.040	**International Treaties/Agreements Identifying Lake**	Yes

Lake Sarygamysh Basin Characteristics



(a) Lake Sarygamysh basin and associated transboundary water systems



(b) Lake Sarygamysh basin land use

Lake Sarygamysh Threat Ranking

A serious lack of global-scale uniform data on the TWAP transboundary in-lake conditions required their potential threat risks be estimated on the basis of the characteristics of their drainage basins, rather than in-lake conditions. Using basin characteristics to rank transboundary lake threats precludes consideration of the unique features that can buffer their in-lake responses to basin-derived disturbances, including an integrating nature for all inputs, long water retention times, and complex, non-linear response dynamics.

The lake threat ranks were calculated with a spreadsheet-based interactive scenario analysis program, incorporating data and information about the nature and magnitude of their basin-derived stresses, and their possible impacts on the sustainability of their ecosystem services. These descriptive data for Lake Sarygamysh and the other transboundary lakes included lake and basin areas, population numbers and densities, areal extent of basin stressors on the lake, data grid size, and other components considered important from the perspective of the user of the data results. The scenario analysis program also provides a means to define the appropriate context and preconditions for interpreting the ranking results.

The Lake Sarygamysh threat ranks are expressed in terms of the Adjusted Human Water Security (Adj-HWS) threats, Reverse Biodiversity (RvBD) threats, and the Human Development Index (HDI) score, as well as combinations of these indices. However, it is emphasized that, being based on specific characteristics and assumptions regarding Lake Sarygamysh and its basin characteristics, the calculated threat scores represent only one possible set of lake threat rankings. Defining the appropriate context and preconditions for interpreting the lake rankings remains an important responsibility of those using the threat ranking results, including lake managers and decision-makers.

Table 1. Lake Sarygamysh Relative Threat Ranks, Based on Adjusted Human Water Security (Adj-HWS) and Reverse Biodiversity Threats, and Human Development Index (HDI) Score

(Estimated risks: red – highest; orange – moderately high; yellow – medium; green – moderately low; blue – low)

Adjusted Human Water Security (Adj-HWS) Threat Score	Relative Adj-HWS Threat Rank		Reverse Biodiversity (RvBD) Threat Score	Relative RvBD Threat Rank		Human Development Index (HDI) Score	Relative HDI Rank
0.82	32		0.75	2		0.67	29

It is emphasized that the Lake Sarygamysh rankings above are discussed here within the context of the management and decision-making process, rather than as strict numerical ranks. Based on its geographic, population and socioeconomic assumptions used in the scenario analysis program, the calculated Adj-HWS score for Lake Sarygamysh indicates a medium threat rank compared to other priority transboundary lakes.

The Reverse Biodiversity (RvBD) for Lake Sarygamysh, which is meant to describe its biodiversity sensitivity to basin-derived degradation, increases the lake to a high threat rank, compared to the other transboundary lakes. Management interventions directed to improving the biodiversity status must be viewed with caution, however, since we lack sufficient knowledge and experience to accurately predict the ultimate impacts of biodiversity manipulations and preservation efforts. Further, the RvBD scores indicate the relative sensitivity of a lake basin to human activities, and high threat scores *per se* do not necessarily justify management interventions. Such interventions may actually increase biodiversity degradation, noting that many developed countries have already fundamentally degraded their biodiversity because of economic development activities. Thus, activities undertaken to address the Adj-HWS threats may actually degrade the biodiversity status and resources, even if the health and socioeconomic conditions of the lake basin stakeholders are improved as a result of better conditions, thereby increasing stakeholder resource consumption.

The relative Human Development Index (HDI) places the Lake Sarygamysh basin in a medium threat rank in regard to its health, educational and economic conditions.

Table 2. Lake Sarygamysh Threat Ranks, Based on Multiple Ranking Criteria

(Scores for Adj-HWS, RvBD and HDI ranks are presented in Table 1; the ranks may differ in some cases because of rounding of tied threat scores; Estimated risks: red – highest; orange – moderately high; yellow – medium;
green – moderately low; blue – low)

Adj-HWS Rank	HDI Rank	RvBD Rank		Sum Adj-HWS + RvBD	Relative Threat Rank		Sum Adj-HWS + HDI	Relative Threat Rank		Sum Adj-HWS + RvBD + HDI	Overall Threat Rank
29	29	2		31	9		58	32		60	21

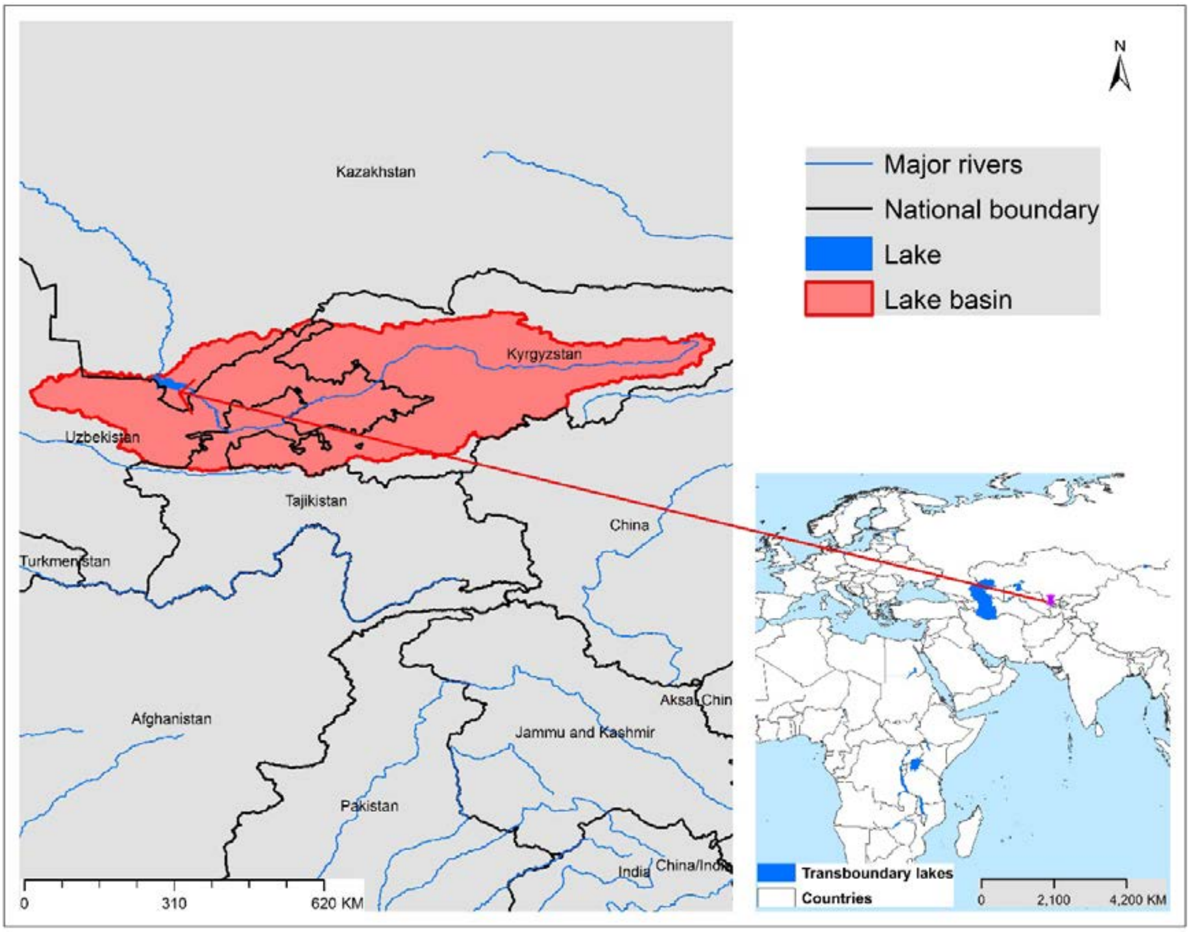
When multiple ranking criteria are considered together in the threat rank calculations, the Adj-HWS and HDI scores considered together place Lake Sarygamysh in the upper half of the threat ranks. The relative threat is notably increased when the Adj-HWS and RvBD threats are considered together. Considering all three ranking criteria together, Lake Sarygamysh exhibits a moderately high threat ranking.

Interactions between the ranking parameters for Lake Sarygamysh indicate differing sensitivity to basin-derived stresses. Identifying potential management interventions needs for Lake Sarygamysh must be considered on the basis of educated judgement and accurate representations of its situation. A fundamental question will be how can one decide a given management intervention will produce the greatest benefit(s) for the greatest number of people in the Lake Sarygamysh basin? Accurate answers to such questions for Lake Sarygamysh, and other transboundary lakes, will require a case-by-case assessment approach that considers the specific lake situation and the anticipated improvements from specific management interventions, as well as interactions with water systems to which the lake is linked.

Lake Shardara/Kara-kul

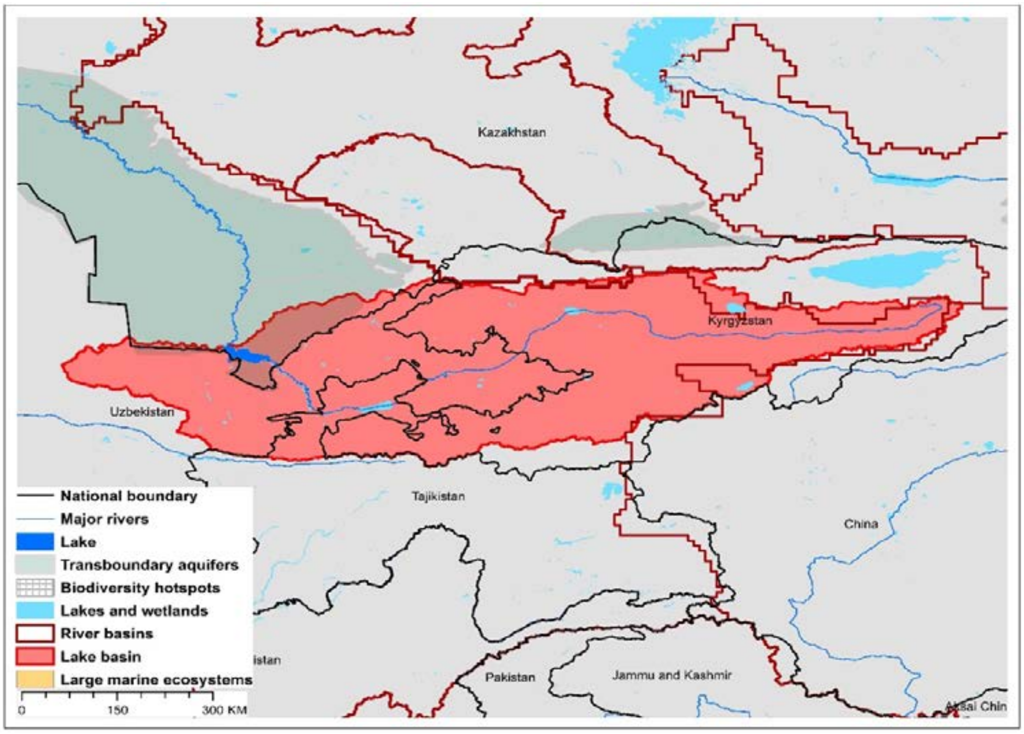
Geographic Information

There is little information available regarding Lake Shardara/Kara-kul, which lies in the Kazakhstan – Uzbekistan region in Central Asia. Its situation is closely related to the Aral Sea in regard to transboundary water management efforts in the part of Central Asia. Thus, assessment of GEF-catalyzed management intervention possibilities also will relate to the outcomes of any international discussions related to the Aral Sea, if there should be a follow-up regarding the latter.

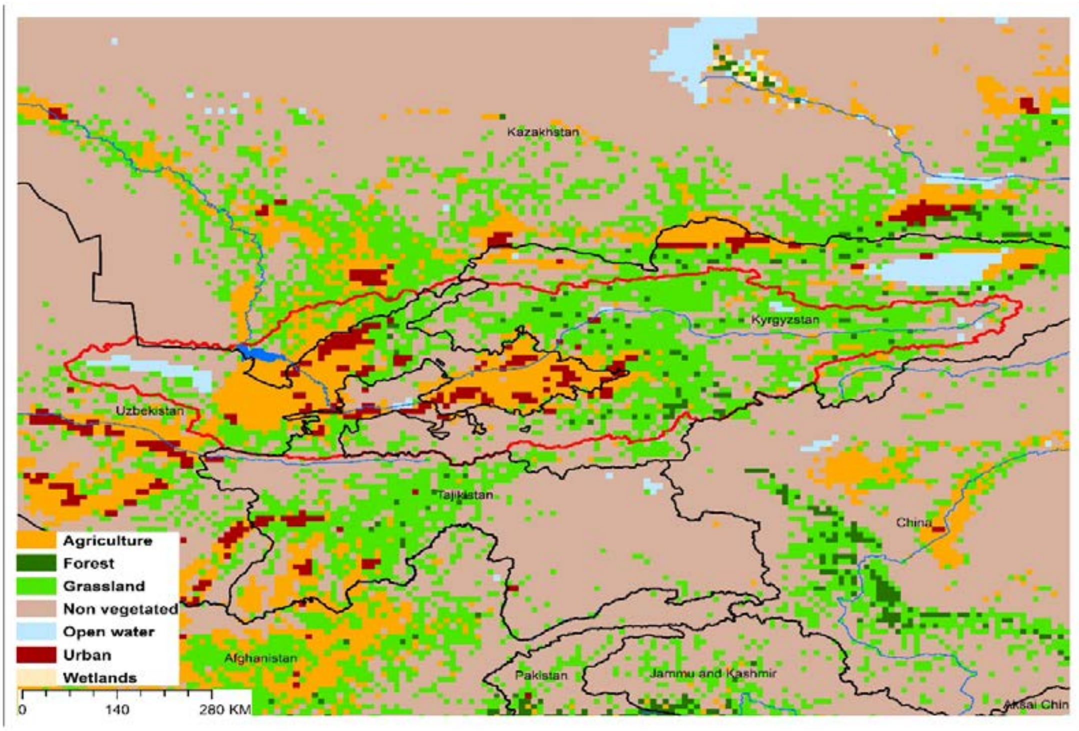


TWAP Regional Designation	Eastern & Central Asia	**Lake Basin Population (2010)**	20,281,740
River Basin	Syr Darya	**Lake Basin Population Density (2010; # km^{-2})**	66.5
Riparian Countries	Kazakhstan, Uzbekistan	**Average Basin Precipitation (mm yr^{-1})**	438.7
Basin Area (km^2)	197,325	**Shoreline Length (km)**	301.6
Lake Area (km^2)	746.1	**Human Development Index (HDI)**	0.65
Lake Area:Lake Basin Ratio	0.004	**International Treaties/Agreements Identifying Lake**	No

Lake Shardara/Kara-kul Basin Characteristics



(a) Lake Shardara/Kara-kul basin and associated transboundary water systems



(b) Lake Shardara/Kara-kul basin land use

Lake Shardara/Kara-kul Threat Ranking

A serious lack of global-scale uniform data on the TWAP transboundary in-lake conditions required their potential threat risks be estimated on the basis of the characteristics of their drainage basins, rather than in-lake conditions. Using basin characteristics to rank transboundary lake threats precludes consideration of the unique features that can buffer their in-lake responses to basin-derived disturbances, including an integrating nature for all inputs, long water retention times, and complex, non-linear response dynamics.

The lake threat ranks were calculated with a spreadsheet-based interactive scenario analysis program, incorporating data and information about the nature and magnitude of their basin-derived stresses, and their possible impacts on the sustainability of their ecosystem services. These descriptive data for Lake Shardara/Kara-kul and the other transboundary lakes included lake and basin areas, population numbers and densities, areal extent of basin stressors on the lake, data grid size, and other components considered important from the perspective of the user of the data results. The scenario analysis program also provides a means to define the appropriate context and preconditions for interpreting the ranking results.

The Lake Shardara/Kara-kul threat ranks are expressed in terms of the Adjusted Human Water Security (Adj-HWS) threats, Reverse Biodiversity (RvBD) threats, and the Human Development Index (HDI) score, as well as combinations of these indices. However, it is emphasized that, being based on specific characteristics and assumptions regarding Lake Shardara/Kara-kul and its basin characteristics, the calculated threat scores represent only one possible set of lake threat rankings. Defining the appropriate context and preconditions for interpreting the lake rankings remains an important responsibility of those using the threat ranking results, including lake managers and decision-makers.

Table 1. Lake Shardara/Kara-kul Relative Threat Ranks, Based on Adjusted Human Water Security (Adj-HWS) and Reverse Biodiversity Threats, and Human Development Index (HDI) Score

(Estimated risks: red – highest; orange – moderately high; yellow – medium; green – moderately low; blue – low)

Adjusted Human Water Security (Adj-HWS) Threat Score	Relative Adj-HWS Threat Rank		Reverse Biodiversity (RvBD) Threat Score	Relative RvBD Threat Rank		Human Development Index (HDI) Score	Relative HDI Rank
0.86	20		0.54	53		0.65	28

It is emphasized that the Lake Shardara/Kara-kul rankings above are discussed here within the context of the management and decision-making process, rather than as strict numerical ranks. Based on its geographic, population and socioeconomic assumptions used in the scenario analysis program, the calculated Adj-HWS score for Lake Shardara/Kara-kul indicates a moderately high threat rank compared to other priority transboundary lakes.

The Reverse Biodiversity (RvBD) for Lake Shardara/Kara-kul, which is meant to describe its biodiversity sensitivity to basin-derived degradation, places the lake in a moderately low threat rank, compared to the other transboundary lakes. Management interventions directed to improving the biodiversity status must be viewed with caution, however, since we lack sufficient knowledge and experience to accurately predict the ultimate impacts of biodiversity manipulations and preservation efforts. Further, the RvBD scores indicate the relative sensitivity of a lake basin to human activities, and high threat scores *per se* do not necessarily justify management interventions. Such interventions may actually increase biodiversity degradation, noting that many developed countries have already fundamentally degraded their biodiversity because of economic development activities. Thus, activities undertaken to address the Adj-HWS threats may actually degrade the biodiversity status and resources, even if the health and socioeconomic conditions of the lake basin stakeholders are improved as a result of better conditions, thereby increasing stakeholder resource consumption.

The relative Human Development Index (HDI) places the Lake Shardara/Kara-kul basin in a medium threat rank in regard to its health, educational and economic conditions.

Table 2. Lake Shardara/Kara-kul Threat Ranks, Based on Multiple Ranking Criteria

(Scores for Adj-HWS, RvBD and HDI ranks are presented in Table 1; the ranks may differ in some cases because of rounding of tied threat scores; Estimated risks: red – highest; orange – moderately high; yellow – medium;
green – moderately low; blue – low)

Adj-HWS Rank	HDI Rank	RvBD Rank		Sum Adj-HWS + RvBD	Relative Threat Rank		Sum Adj-HWS + HDI	Relative Threat Rank		Sum Adj-HWS + RvBD + HDI	Overall Threat Rank
22	28	35		57	21		50	27		85	29

When multiple ranking criteria are considered together in the threat rank calculations, the Adj-HWS and HDI scores considered together place Lake Shardara/Kara-kul in the upper half of the threat ranks. The relative threat is similar when the Adj-HWS and RvBD threats are considered together. Considering all three ranking criteria together, Lake Shardara/Kara-kul exhibits a medium threat ranking.

Interactions between the ranking parameters for Lake Shardara/Kara-kul indicate differing sensitivity to basin-derived stresses. Identifying potential management interventions needs for Lake Shardara/Kara-kul must be considered on the basis of educated judgement and accurate representations of its situation. A fundamental question will be how can one decide a given management intervention will produce the greatest benefit(s) for the greatest number of people in the Lake Shardara/Kara-kul basin? Accurate answers to such questions for Lake Shardara/Kara-kul, and other transboundary lakes, will require a case-by-case assessment approach that considers the specific lake situation and the anticipated improvements from specific management interventions, as well as interactions with water systems to which the lake is linked.

METHODOLOGY AND CAVEATS REGARDING TRANSBOUNDARY LAKE THREAT RANKS

A serious lack of global-scale uniform data on the TWAP transboundary in-lake conditions required their potential risks be estimated on the basis of the characteristics of their drainage basins, rather than analysis of their in-lake conditions. The lake threat ranks were calculated with a scenario analysis program that allowed incorporation of specific assumptions and preconditions about the nature and magnitude of their basin-derived stresses, and their possible impacts on the sustainability of their ecosystem services, as defined by the user of the ranking results. Because the transboundary lake threat ranks are based on specific lake and basin assumptions, therefore, the calculated rankings represent only one possible set of lake rankings.

Using basin characteristics to rank transboundary lake threats precludes consideration of the unique features that can buffer their in-lake responses to basin-derived disturbances, including an integrating nature for all inputs, long water retention times, and complex, non-linear response dynamics. A global overview of river basin threats based on 23 basin-scale drivers under four thematic areas (catchment disturbance; pollution; water resource development; biotic factors) was modified for the transboundary lakes assessment. The driver weights were initially based on collective opinions of experts exhibiting a range of disciplinary expertise, subsequently being refined with inputs from lake scientists and managers participating in ILEC's 15th World Lake Conference.

A spreadsheet-based, interactive scenario analysis program was used to rank the transboundary lake threats. The lake basin characteristics were determined by superimposing the lake basins over the river basin grids, and scaling the driver data to lake basin scale. Selected basin drivers, weights and preconditions were used in the scenario analysis program to calculate the relative lake threat ranks, expressed in terms of the Incident (HWS) and Adjusted (Adj-HWS) Human Water Security and Incident Biodiversity (BD) threats.

The transboundary lake analyses incorporated several assumptions and preconditions. Small transboundary lakes (area <5 km^2), sparse basin populations (< 5 persons km^{-1}), or that were frozen over for major portions of the year (annual air temperature <5 ^{o}C), were eliminated from the analyses. The areal extent of the influences of the basin drivers was addressed with a sensitivity analysis that indicated an areal band of 100 km^2 around a lake, appropriately clipped for the surrounding basin, was a realistic upper boundary for the scenario analysis program. The river basin grid size was problematic in that some grids (30' grid [0.5^o]) were often larger than those of some transboundary lake basins, and about 10% of the transboundary lakes lacked driver data for some grids. Based on these considerations, a final list of 53 priority transboundary lakes was selected for the scenario analysis program calculations of relative threat scores.

Insights obtained from lake scientists and managers participating in the 15th World Lake Conference helped address some of these concerns. Region-specific lake questionnaires also were distributed in some cases, obtaining both quantitative and qualitative data regarding the transboundary lakes and their basins.

These various factors and concerns indicate the transboundary lake threat ranks must be considered within the context of the specific basin conditions and assumptions used to derive them, since they represent only one possible set of lake threat rankings. Other factors such as lake and basin area, basin population and density, regional location, per capita Gross National Income (GNI), and Human

Development Index (HDI) could produce markedly different ranking results. Defining the appropriate context and preconditions for interpreting the lake ranking results, a task beyond the scope of this analysis, remains an important responsibility of those using the results, including lake managers and decision-makers.

The calculated ranks of the priority transboundary lakes, based on the specific assumptions and preconditions regarding the lakes and their drainage basins, is expressed below in terms of Adjusted Human Water Security (Adj-HWS) threats, Reverse Biodiversity (RvBD) threats, and Human Development Index (HDI) status. The Incident Human Water Security (HWS) score would suggest the current threat ranks of the lakes. However, for identifying needed management interventions, the ability of the basin countries to undertake investments to reduce identified transboundary water threats (i.e., water supply stabilization, improved water services, etc.) is also a relevant factor. This ability is considered within the context of the Adj-HWS threat. Countries less able to make such investments, mainly developing countries, exhibited higher Adj-HWS threats. Thus, the Adj-HWS threat ranks provide a more realistic picture of the transboundary lakes most in need of catalytic funding for management interventions than those with lower Adj-HWS scores.

Our more limited knowledge and experience regarding the ultimate outcomes of ecosystem restoration and conservation activities precluded a BD metric identical to the Adj-HWS threat. The Adj-HWS threat rank is meant to identify the transboundary lakes in most need of management interventions from a water investment perspective. The native biodiversity of most developed countries, however, has already been largely degraded as a result of their economic development activities. Thus, the preservation of those ecosystems still exhibiting the most pristine or undisturbed conditions should be the major BD management intervention goal. To address this goal, a RvBD threat was developed as a BD surrogate to define relative BD threats. It was calculated as 1-BD score, with the resulting RvBD score indicating the relative ‘pristineness’ of a lake in regard to its biodiversity status. The higher RvBD scores calculated with this normalization procedure identify the transboundary lakes most likely to be sensitive to BD degradation and, therefore, the lakes most in need of management attention.

The Human Development Index (HDI) is a composite statistic used by the United Nations Development Programme (UNDP) to reflect the relative life expectancy, education level, and per capita income of a country. A country whose inhabitants exhibit longer life spans, higher education levels, and higher per capita GDPs typically exhibit higher HDI scores, suggesting a higher overall condition of its citizens. It is meant to indicate that economic growth alone is not the sole criteria to assessment of a country, but that the status of its citizens and their capabilities also are important defining factors, therefore being an indication of potential human development.

Along with the assumptions and preconditions defining specific lake basin characteristics, these three criteria were major indicators considered within the context of the scenario analysis program to calculate the relative threat ranks of the transboundary lakes, as presented in the transboundary lake profile sheets.

Transboundary Lakes Ranked on Basis of (a) Incident Human Water Security [HWS] Threats, (b) Adjusted Human Water Security [Adj-HWS] Threats, and (c) Incident Biodiversity [BD] Threats

(Cont., continent; Eur, Europe; N.Am, North America; Afr., Africa; S.Am, South America; Estimated risks: red – highest; orange – moderately high; yellow – medium; green – moderately low; blue – low)

(A) Lakes Ranked on Basis of Adjusted Human Water Security (Adj-HWS) Threats

Lake	Cont.	Surface Area (km^2)	Adj-HWS Threat Score	Rank
Sistan	Asia	488.2	0.98	1
Ihema	Afr.	93.2	0.97	2
Azuei	S.Am	117.3	0.96	3
Rweru/Moero	Afr.	125.6	0.96	4
Cohoha	Afr.	64.8	0.96	5
Edward	Afr.	2232.0	0.94	6
Natron/Magadi	Afr.	560.4	0.93	7
Abbe/Abhe	Afr.	310.6	0.93	8
Victoria	Afr.	66841.5	0.91	9
Albert	Afr.	5502.3	0.91	10
Kivu	Afr.	2371.1	0.91	11
Malawi/Nyasa	Afr.	29429.2	0.91	12
Dead Sea	Eur	642.7	0.90	13
Turkana	Afr.	7439.2	0.90	14
Aras Su Qovsaginin Su Anbari	Asia	52.1	0.89	15
Mangla	Asia	85.4	0.87	16
Galilee	Eur	162.0	0.87	17
Darbandikhan	Asia	114.3	0.87	18
Selingue	Afr.	334.4	0.87	19
Shardara/Kara-Kul	Asia	746.1	0.86	20
Nasser/Aswan	Afr.	5362.7	0.86	21
Chilwa	Afr.	1084.2	0.86	22
Josini/Pongola-poort Dam	Afr.	128.6	0.85	23

(B) Lakes Ranked on Basis of Reverse Biodiversity (RvBD) Threats

Lake	Cont.	Surface area (km^2)	RvBD Threat Score	Rank
Lake Congo River	Afr.	306.0	0.80	1
Sarygamysh	Asia	3777.7	0.75	2
Chiuta	Afr.	143.3	0.74	3
Mweru	Afr.	5021.5	0.72	4
Aral Sea	Asia	23919.3	0.72	5
Tanganyika	Afr.	32685.5	0.71	6
Abbe/Abhe	Afr.	310.6	0.71	7
Titicaca	S.Am	7480.0	0.71	8
Chilwa	Afr.	1084.2	0.70	9
Salto Grande	S.Am	532.9	0.70	10
Turkana	Afr.	7439.2	0.70	11
Cahora Bassa	Afr.	4347.4	0.69	12
Chungarkkota	S.Am	52.6	0.69	13
Malawi/Nyasa	Afr.	29429.2	0.68	14
Nasser/Aswan	Afr.	5362.7	0.68	15
Selingue	Afr.	334.4	0.68	16
Kivu	Afr.	2371.1	0.67	17
Natron/Magadi	Afr.	560.4	0.67	18
Lago de Yacyreta	S.Am	1109.4	0.66	19
Kariba	Afr.	5258.6	0.66	20
Edward	Afr.	2232.0	0.65	21
Aby	Afr.	438.8	0.65	22
Chad	Afr.	1294.6	0.64	23

(C) Lakes Ranked on Basis of Human Development Index (HDI) Scores

Lake	Cont.	Surface area (km^2)	HDI Score	Rank
Lake Congo River	**Afr**	**306.0**	**0.34**	**1**
Selingue	**Afr**	**334.4**	**0.36**	**2**
Rweru/Moero	**Afr**	**125.6**	**0.36**	**3**
Cohoha	**Afr**	**64.8**	**0.38**	**4**
Kivu	**Afr**	**2371.1**	**0.38**	**5**
Mweru	**Afr**	**5021.5**	**0.38**	**6**
Abbe/Abhe	**Afr**	**310.6**	**0.40**	**7**
Tanganyika	**Afr**	**32685.5**	**0.40**	**8**
Turkana	**Afr**	**7439.2**	**0.41**	**9**
Chiuta	**Afr**	**143.3**	**0.41**	**10**
Chilwa	**Afr**	**1084.2**	**0.41**	**11**
Malawi/Nyasa	**Afr**	**29429.2**	**0.42**	**12**
Edward	**Afr**	**2232.0**	**0.43**	**13**
Nasser/Aswan	**Afr**	**5362.7**	**0.43**	**14**
Cahora Bassa	**Afr**	**4347.4**	**0.43**	**15**
Chad	**Afr**	**1294.6**	**0.43**	**16**
Kariba	**Afr**	**5358.6**	**0.43**	**17**
Ihema	**Afr**	**93.2**	**0.44**	**18**
Sistan	**Asia**	**488.2**	**0.46**	**19**
Albert	**Afr**	**5502.3**	**0.46**	**20**
Azuei	**S.Am,**	**117.3**	**0.46**	**21**
Victoria	**Afr**	**66841.5**	**0.47**	**22**
Natron/Magadi	**Afr**	**560.4**	**0.51**	**23**

	Afr.	143.3	0.85	24		Albert	Afr.	5502.3	0.63	24		**Aby**	**Afr**	**438.8**	**0.52**	**24**
Chad	Afr.	1294.6	0.84	25		Sistan	Asia	488.2	0.62	25		**Mangla**	**Asia**	**85.4**	**0.54**	**25**
Aral Sea	Asia	23919.3	0.84	26		Amistad	N.Am	131.3	0.61	26		**Aral Sea**		**23919.3**	**0.60**	**26**
Tanganyika	Afr.	32685.5	0.84	27		Caspian Sea	Asia	377543.2	0.60	27		**Josini/Pongola-poort Dam**	**Afr**	**128.6**	**0.61**	**27**
Aby	Afr.	438.8	0.83	28		Cohoha	Afr.	64.8	059	28		**Shardara/Kara-kul**	**Asia**	**746.1**	**0.65**	**28**
Cahul	Eur	89.0	0.82	29		Itaipu	S.Am	1154.1	0.58	29		**Sarygamysh**	**Asia**	**3777.7**	**0.67**	**29**
Chungarkkota	S.Am	52.6	0.82	30		Rweru/Moero	Afr.	125.6	0.58	30		**Darbandikhan**	**Asia**	**114.3**	**0.68**	**30**
Titicaca	S.Am	7480.0	0.82	31		Azuei	S.Am	117.3	0.57	31		**Cahul**	**Eur**	**89.0**	**0.69**	**31**
Sarygamysh	Asia	3777.7	0.82	32		Ihema	Afr.	93.2	0.56	32		**Titicaca**	**S.Am**	**7480.0**	**0.71**	**32**
Mweru	Afr.	5021.5	0.81	33		Victoria	Afr.	66841.5	0.56	33		**Chungarkkota**	**S.Am**	**52.6**	**0.71**	**33**
Cahora Bassa	Afr.	4347.4	0.78	34		Scutari/Skadar	Eur	381.5	0.55	34		**Dead Sea**	**Eur**	**642.7**	**0.72**	**34**
Itaipu	S.Am	1154.1	0.75	35		Shardara/Kara-Kul	Asia	746.1	0.54	35		**Lago de Yacyreta**	**S.Am**	**1109.4**	**0.73**	**35**
Kariba	Afr.	5258.6	0.75	36		Huron	N.Am	60565.2	0.53	36		**Aras Su Qovsaginin Su Anbari**	**Asia**	**52.1**	**0.73**	**36**
Lago de Yacyreta	S.Am	1109.4	0.75	37		Josini/Pongola-poort Dam	Afr.	128.6	0.52	37		**Itaipu**	**S.Am**	**1154.1**	**0.73**	**37**
Lake Congo River	Afr.	306.0	0.75	38		Champlain	N.Am	1098.9	0.51	38		**Salto Grande**	**S.Am**	**532.9**	**0.74**	**38**
Caspian Sea	Asia	377543.2	0.73	39		Ohrid	Eur	354.3	0.51	39		**Ohrid**	**Eur**	**354.3**	**0.74**	**39**
Salto Grande	S.Am	532.9	0.67	40		Macro Prespa	Eur	263.0	0.51	40		**Macro Prespa**	**Eur**	**263.0**	**0.75**	**40**
Scutari/Skadar	Eur	381.5	0.62	41		Dead Sea	Eur	642.7	0.51	41		**Caspian Sea**	**Asia**	**377543.2**	**0.77**	**41**
Neusiedler/Ferto	Eur	141.9	0.58	42		Maggiore	Eur	211.4	0.49	42		**Scutari/Skadar**	**Eur**	**381.5**	**0.78**	**42**
Szczecin Lagoon	Eur	822.4	0.53	43		Szczecin Lagoon	Eur	822.4	0.49	43		**Szczecin Lagoon**	**Eur**	**822.4**	**0.83**	**43**
Erie	N.Am	26560.8	0.51	44		Ontario	N.Am	19062.2	0.47	44		**Falcon**	**N.Am**	**120.6**	**0.85**	**44**
Macro Prespa)	Eur	263.0	0.51	45		Aras Su Qovsaginin Su Anbari	Asia	52.1	0.47	45		**Amistad**	**N.Am**	**131.3**	**0.86**	**45**
Falcon	N.Am	120.6	0.50	46		Darbandikhan	Asia	114.3	0.46	46		**Galilee**	**Eur**	**162.0**	**0.88**	**46**
Amistad	N.Am	131.3	0.49	47		Galilee	Eur	162.0	0.45	47		**Neusiedler/Ferto**	**Eur**	**141.9**	**0.88**	**47**
Ontario	N.Am	19062.2	0.48	48		Michigan	N.Am	58535.5	0.44	48		**Lake Maggiore**	**Eur**	**211.4**	**0.89**	**48**
Ohrid	Eur	354.3	0.47	49		Erie	N.Am	26560.8	0.43	49		**Ontario**	**N.Am**	**19062.2**	**0.92**	**49**
Michigan	N.Am	58535.5	0.44	50		Neusiedler/Ferto	Eur	141.9	0.39	50		**Huron**	**N.Am**	**60565.2**	**0.93**	**50**
Huron	N.Am	60565.2	0.42	51		Cahul	Eur	89.0	0.39	51		**Erie**	**N.Am**	**26560.8**	**0.93**	**51**
Maggiore	Eur	211.4	0.33	52		Mangla	Asia	85.4	0.38	52		**Champlain**	**N.Am**	**1098.9**	**0.94**	**52**
Champlain	N.Am	1098.9	0.29	53		Falcon	N.Am	120.6	0.38	53		**Michigan**	**N.Am**	**58535.5**	**0.94**	**53**

Transboundary Lake Threat Ranks by Multiple Ranking Criteria

(Cont., continent; Eur, Europe; N.Am, North America; Afr, Africa; S.Am, South America;
Adj-HWS, Adjusted Human Water Security threat; HWS, Incident Human Water Security threat; BD, Incident Biodiversity threat;
HDI, Human Development Index, RvBD, surrogate for 'Adjusted' Biodiversity threat;
Estimated risks: Red – highest; Orange – moderately high; Yellow – medium; Green – moderately low; Blue – low)

Cont.	Lake Name	Adj-HWS Threat	RvBD Threat	HDI	Adj-HWS Rank	HDI Rank	RvBD Rank	Sum Adj-HWS + RvBD	Relative Rank	Sum Adj-HWS + HDI	Relative Rank	Sum Adj-HWS + RvBD + HDI	Overall Rank
Afr	Abbe/Abhe	0.93	0.71	0.40	7	7	7	14	1	14	3	21	1
Afr	Turkana	0.90	0.70	0.41	13	10	9	22	2	23	10	32	2
Afr	Selingue	0.87	0.68	0.36	16	2	15	31	11	18	5	33	3
Afr	Malawi/Nyasa	0.91	0.68	0.42	9	12	14	23	3	21	9	35	4
Afr	Chiuta	0.85	0.74	0.41	23	9	3	26	5	32	15	35	4
Afr	Cohoha	0.96	0.59	0.38	3	4	28	31	2	7	1	35	4
Afr	Kivu	0.91	0.67	0.38	12	6	18	30	8	18	4	36	7
Afr	Rweru/Moero	0.96	0.58	0.36	4	3	30	34	16	7	2	37	8
Afr	Lake Congo River	0.75	0.78	0.34	35	1	1	36	18	36	19	37	8
Afr	Tanganyika	0.84	0.71	0.40	26	8	6	32	14	34	17	40	10
Afr	Edward	0.94	0.65	0.43	6	13	22	28	7	19	6	41	11
Afr	Chilwa	0.86	0.70	0.41	21	11	10	31	10	32	14	42	12
Afr	Mweru	0.81	0.72	0.38	33	5	4	37	21	38	20	42	12
Asia	Sistan	0.98	0.62	0.46	1	20	25	26	6	21	8	46	14
Afr	Natron/Magadi	0.93	0.67	0.51	8	23	17	25	4	31	13	48	15
Afr	Nasser/Aswan	0.86	0.68	0.43	20	16	16	36	19	36	18	52	16
Afr	Albert	0.91	0.63	0.46	10	19	24	34	15	29	12	53	17
Afr	Ihema	0.97	0.56	0.44	2	18	33	35	17	20	7	53	17
S.Am,	Azuei	0.96	0.57	0.46	5	21	31	36	20	26	11	57	19
Asia	Aral Sea	0.84	0.62	0.60	27	26	5	32	13	53	31	58	20
Asia	Sarygamysh	0.82	0.75	0.67	29	29	2	31	9	58	32	60	21
Afr	Cahora Bassa	0.78	0.69	0.43	34	15	13	47	25	49	25	62	22
Afr	Victoria	0.91	0.56	0.47	11	22	32	43	24	33	16	65	23
Afr	Chad	0.84	0.64	0.43	25	17	23	48	26	42	21	65	23
Afr	Kariba	0.75	0.66	0.43	36	14	19	55	30	50	28	69	25

S.Am	Titicaca	0.82	0.71	0.71	32	32	8	40	22	25	35	72	26
Afr	Aby	0.83	0.65	0.52	28	24	21	49	27	52	30	73	27
S.Am	Chungarkkota	0.82	0.69	0.71	31	33	12	43	23	64	34	76	28
Asia	Shardara/Kara-kul	0.86	0.54	0.65	22	28	35	57	31	50	27	85	29
Eur	Dead Sea	0.90	0.51	0.72	14	34	38	52	29	48	24	86	30
Afr	Josini/Pongola-poort Dam	0.85	0.52	0.61	24	27	37	61	34	51	29	88	31
S.Am	Salto Grande	0.67	0.70	0.74	40	38	11	51	28	78	39	89	32
Asia	Darbandikhan	0.87	0.46	0.68	17	30	46	63	35	47	23	93	33
S.Am	Lago de Yacyreta	0.75	0.66	0.73	38	36	20	58	32	74	38	94	34
Asia	Aras Su Qovsaginin Su Anbari	0.89	0.47	0.73	15	35	44	59	33	50	26	94	34
Asia	Mangla	0.87	0.38	0.54	18	25	53	71	39	43	22	96	36
S.Am	Itaipu	0.75	0.58	0.73	37	37	29	66	37	74	37	103	37
Asia	Caspian Sea	0.73	0.60	0.77	39	41	27	66	36	80	40	107	38
Eur	Galilee	0.87	0.45	0.88	19	46	47	66	38	65	36	112	39
Eur	Cahul	0.82	0.39	0.69	30	31	51	81	42	61	33	112	39
Eur	Scutari/Skadar	0.62	0.55	0.78	41	42	34	75	41	83	41	117	41
N.Am	Amistad	0.49	0.61	0.86	47	45	26	73	40	47	40	118	42
Eur	Macro Prespa (Large Prespa)	0.51	0.51	0.75	44	40	40	84	43	84	42	124	43
Eur	Ohrid	0.47	0.51	0.74	49	39	39	88	46	88	44	127	44
Eur	Szczecin Lagoon	0.53	0.49	0.83	43	43	43	86	44	86	43	129	45
N.Am	Huron	0.42	0.53	0.93	51	50	36	87	45	101	51	137	46
Eur	Neusiedler/Ferto	0.58	0.39	0.88	42	47	50	92	47	89	45	139	47
N.Am	Ontario	0.48	0.47	0.92	48	49	45	93	48	97	49	142	48
Eur	Lake Maggiore	0.33	0.50	0.89	52	48	42	94	50	100	50	142	48
N.Am	Falcon	0.50	0.38	0.85	46	44	52	98	53	90	46	142	48
N.Am	Erie	0.51	0.43	0.93	45	51	49	94	51	96	48	145	51
N.Am	Champlain	0.29	0.51	0.94	53	52	41	94	49	105	53	146	52
N.Am	Michigan	0.44	0.44	0.94	50	53	48	98	52	103	52	151	53

1. Amur
2. Aral Sea
3. Atrak
4. Beilun
5. Ganges-Brahmaputra-Meghna
6. Han
7. Hari/ Harirud
8. Har Us Nur
9. Bei Jiang/ His
10. Ili/ Kunes He
11. Indus
12. Irrawaddy
13. Lake Ubsa-Nur
14. Mekong
15. Murgab
16. Ob
17. Oral/ Ural
18. Pu Lun T'o
19. Red/ Song Hong
20. Salween
21. Shu/ Chu
22. Sujfun
23. Talas
24. Tarim
25. Tumen
26. Volga
27. Yalu
28. Jenisej/ Yenisey

UNEP-DHI PARTNERSHIP
Centre on Water and Environment
UNEP DHI
IUCN
SIWI
CUNY The City University of New York
OSU Oregon State University
GLOBAL IGBP CHANGE International Geosphere-Biosphere Programme
Center for International Earth Science Information Network
EARTH INSTITUTE | COLUMBIA UNIVERSITY
CESR Center for Environmental Systems Research
Delta Alliance

NASA

Vmenkov

Amur Basin

Geography

Total drainage area (km²)	2,092,690
No. of countries in basin	4
BCUs in basin	China (CHN), Dem People's Rep of Korea (PRK), Mongolia (MNG), Russian Federation (RUS)
Population in basin (people)	65,216,853
Country at mouth	Russian Federation
Average rainfall (mm/year)	521

Governance

No. of treaties and agreements[1]	5
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	32
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km³/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km³/year)	Av. Groundwater Discharge (km³/year)	Lake and Reservoir Surface Area (km²)	Lake and Reservoir Volume (km³)
AMUR_CHN		115.56			4,656.10	29.73
AMUR_MNG		20.01			746.14	5.34
AMUR_PRK						
AMUR_RUS		251.83			8,275.46	85.26
Total in Basin	363.74	173.81			13,677.70	120.33

Water Withdrawals

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

BCU	Total (km³/year)	Irrigation (km³/year)	Livestock (km³/year)	Electricity (km³/year)	Manufacture (km³/year)	Domestic (km³/year)	Per capita (m³/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
AMUR_CHN	24,959.08	18,014.52	229.48	2,860.12	1,564	2,291.36	403.74	
AMUR_MNG								
AMUR_PRK								
AMUR_RUS	1,211.15	167.84	18.09	409.49	185	430.91	373.40	
Total in Basin	26,466.22	18,275.37	257.29	3,454.35	1,749.01	2,730.21	405.82	7.28

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km²)
AMUR_CHN	889	0.42	61,820	69.53	0.51	0.02	99.98	52	6,807.43	5	5.62
AMUR_MNG	195	0.09	152	0.97	1.58	44.50			2,286.00	0	0.00
AMUR_PRK	0	0.00	1	21.11				0	0.00	0	0.00
AMUR_RUS	1,008	0.48	3,244	3.22	-0.12	0.00	100.00	4	14,611.70	1	0.99
Total in Basin	2,093	1.00	65,217	31.16	0.48	0.02	99.98	56	7,189.04	6	2.87

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
AMUR_CHN	2	4	3		5	2	3	3	4	2	3	2	1	2	3
AMUR_MNG	2	4	2		5	4	2	2	4	2	3	5	1	2	4
AMUR_PRK					5	2			3	5	3	4	1	3	1
AMUR_RUS	2	1	2		4	2	2	3	4	3	4	2	1	2	3
River Basin	2	2	2	3	5	2	2	3	4	2	3	2	1	2	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low	Low	Medium	High	Very high

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
AMUR_CHN	3	3	4	5			1	1	3
AMUR_MNG	4	4	4	4			2	2	3
AMUR_PRK									3
AMUR_RUS	3	3	1	1			1	1	4
River Basin	3	3	2	3	3	4	1	1	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	2				

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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GEF TWAP is the first global-scale assessment of all transboundary water systems. The TWAP consists of five independent indicator-based water system assessments and the linkages between them, including their socioeconomic and governance-related features. The United Nations Environment Programme (UNEP) is the implementing agency of TWAP. Project Coordination Unit (PCU) in Nairobi, Kenya coordinates the work of UNESCO-IHP, ILEC, UNEP-DHI and the IOC of UNESCO on Transboundary Aquifers, Lake Basins, River Basins, Large Marine Ecosystems and Open Ocean respectively. Each executing partner engages a broad network of data and information rich partners with responsibilities either of a thematic or geographic nature. More on TWAP full size project at http://www.geftwap.org .

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Disputed areas
The GAUL project and original dataset maintains disputed areas in such a way to preserve national integrity for all disputing countries. The GAUL Set reports the international, first level and second level administrative boundaries delimiting, or falling within, the disputed areas in a way to enable the re-construction of the administrative units as they are specified by the individual disputing countries. Disputed areas are therefore shown as individual entities, not dependent from countries, with corresponding coding. Same approach has been taken by TWAP RB, reporting on disputed territories, as well as presentation of Basin Country Units.

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For more information on data sources, indicator calculation methodologies, limitations and more consult indicator metadata sheets available on TWAP RB Data portal on http://twap-rivers.org .

Aral Sea Basin

Geography

Total drainage area (km^2)	1,218,514
No. of countries in basin	9
BCUs in basin	Afghanistan (AFG), China (CHN), Jammu and Kashmir (CHN/IND/PAK), Kazakhstan (KAZ), Kyrgyzstan (KGZ), Pakistan (PAK), Tajikistan (TJK), Turkmenistan (TKM), Uzbekistan (UZB)
Population in basin (people)	50,052,293
Country at mouth	Kazakhstan, Uzbekistan
Average rainfall (mm/year)	277

Governance

No. of treaties and agreements[1]	12
No. of RBOs and Commissions[2]	4

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	26
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
ARAL_AFG		152.08			50.10	0.28
ARAL_CHN						
ARAL_CHN/IND/PAK						
ARAL_KAZ		58.48			35,953.32	1,052.79
ARAL_KGZ		183.11			559.17	23.26
ARAL_PAK						
ARAL_TJK		283.48			909.70	64.50
ARAL_TKM		34.42				

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

ARAL_UZB		47.27			32,040.61	944.50
Total in Basin	126.09	103.48			69,512.90	2,085.34

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
ARAL_AFG	23,182.41	22,882.68	22.35	13.38	80	183.83	2,451.97	
ARAL_CHN								
ARAL_CHN/IND/PAK								
ARAL_KAZ	12,543.10	11,783.48	14.72	153.73	358	232.91	5,337.13	
ARAL_KGZ	4,189.63	3,718.16	23.03	8.25	82	357.95	1,233.78	
ARAL_PAK								
ARAL_TJK	8,750.53	7,166.32	16.29	16.08	843	708.84	1,319.86	
ARAL_TKM	4,006.23	3,750.04	4.84	103.56	63	84.45	3,436.33	
ARAL_UZB	53,973.95	48,720.07	108.92	1,291.89	516	3,336.82	1,995.02	
Total in Basin	106,645.86	98,020.75	190.15	1,586.88	1,943.30	4,904.79	2,130.69	84.58

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
ARAL_AFG	166	0.14	9,455	56.82	2.58	0.00	100.00	3	678.35	0	0.00
ARAL_CHN	0	0.00	1	3.13	0.51			0	6,807.43	0	0.00
ARAL_CHN/IND/PAK	0	0.00	0	52.10				0		0	0.00
ARAL_KAZ	358	0.29	2,350	6.56	1.10	0.00	100.00	2	13,171.81	2	5.59
ARAL_KGZ	119	0.10	3,396	28.59	1.13	8.76	91.24	2	1,263.45	6	50.51
ARAL_PAK	0	0.00	0	9.66	1.80			0	1,299.12	0	0.00
ARAL_TJK	141	0.12	6,630	47.00	1.28	0.67	99.33	2	1,036.58	6	42.54
ARAL_TKM	58	0.05	1,166	20.06	1.20	0.00	100.00	1	7,986.70	0	0.00
ARAL_UZB	376	0.31	27,054	71.97	1.12	0.00	100.00	15	1,878.09	9	23.94
Total in Basin	1,219	1.00	50,052	41.08	1.85	0.68	99.31	25	2,170.92	23	18.88

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
ARAL_AFG	4	4	5		5	2	2	3	3	4	3		2	3	3
ARAL_CHN					5	1			3	4	3	2	1	3	1
ARAL_CHN/IND/PAK									3	5	3		1	5	1
ARAL_KAZ	3	4	5		4	3	4	2	3	2	3	3	3	2	3
ARAL_KGZ	3	3	3		5	3	4	2	3	2	1		3	2	3
ARAL_PAK					5	4			3	5	3	3	1	3	1
ARAL_TJK	2	3	3		5	3	4	3	3	2	1	5	5	2	3
ARAL_TKM	4	5	5		5	4	3	4	3	2	2	3	3	3	2
ARAL_UZB	5	5	5		5	2	4	2	3	2	3	3	5	2	3
River Basin	4	4	5	2	5	3	4	3	3	2	3		5	3	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**Projected**
ARAL_AFG	5	5	4	5			3	5	4
ARAL_CHN							1	2	3
ARAL_CHN/IND/PAK									3
ARAL_KAZ	5	5	4	4			1	2	3
ARAL_KGZ	5	5	3	3			2	2	1
ARAL_PAK									3
ARAL_TJK	5	5	3	3			2	3	2
ARAL_TKM	5	5	5	5			2	3	2
ARAL_UZB	5	5	5	5			2	3	3
River Basin	5	5	5	5	2	2	2	3	3

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	5				

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Atrak Basin

Geography

Total drainage area (km^2)	36,421
No. of countries in basin	2
BCUs in basin	Iran (Islamic Republic of) (IRN), Turkmenistan (TKM)
Population in basin (people)	1,098,623
Country at mouth	Turkmenistan
Average rainfall (mm/year)	325

Governance

No. of treaties and agreements[1]	3
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	1
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
ATRK_IRN		126.93				
ATRK_TKM		89.41				
Total in Basin	3.97	108.94			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
ATRK_IRN	3,803.63	3,426.36	6.08	203.54	31	136.70	3,629.73	
ATRK_TKM	2,909.03	2,607.08	3.65	207.11	27	63.92	57,361.00	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	6,712.66	6,033.44	9.73	410.65	58.22	200.62	6,110.07	169.19

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km²)
ATRK_IRN	25	0.68	1,048	42.40	1.18	0.00	100.00	1	4,763.30	0	0.00
ATRK_TKM	12	0.32	51	4.33	1.20			0	7,986.70	0	0.00
Total in Basin	36	1.00	1,099	30.16	1.33	0.00	95.38	1	4,912.10	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
ATRK_IRN	4	5	5		5	1	3	3	3	2	2	2	1	3	3
ATRK_TKM	4	5	5		5	2	2	2	3	3	2	3	1	3	3
River Basin	4	5	5	2	5	1	3	3	3	2	2	2	1	3	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low | Low | Medium | High | Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**Projected**
ATRK_IRN	5	5	5	5			1	2	2
ATRK_TKM	5	5	5	5			1	2	2
River Basin	5	5	5	5	5	5	1	2	2

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	1				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Bei Jiang/Hsi Basin

Geography

Total drainage area (km^2)	401,083
No. of countries in basin	2
BCUs in basin	China (CHN), Viet Nam (VNM)
Population in basin (people)	77,098,396
Country at mouth	China
Average rainfall (mm/year)	1,450

Governance

No. of treaties and agreements[1]	0
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	7
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
HSIX_CHN		728.63			427.20	17.01
HSIX_VNM		626.16				
Total in Basin	291.06	725.69			427.20	17.01

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
HSIX_CHN	43,564.12	26,128.97	386.36	6,620.98	6,149	4,278.33	572.92	
HSIX_VNM	544.75	324.71	5.24	37.58	0	177.21	514.12	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	44,108.87	26,453.68	391.61	6,658.56	6,149.48	4,455.54	572.11	15.15

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km²)
HSIX_CHN	390	0.97	76,039	195.22	0.51	0.00	100.00	40	6,807.43	49	125.80
HSIX_VNM	12	0.03	1,060	91.56	1.10	0.00	100.00	0	1,910.53	0	0.00
Total in Basin	401	1.00	77,098	192.23	0.50	0.00	100.00	40	6,740.13	49	122.17

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
HSIX_CHN	2	3	2		5	2	4	4	5	5	5	2	2	3	3
HSIX_VNM	1	2	2		5		3		3	4	5	5	1	3	3
River Basin	2	3	2	5	5	2	4	4	3	5	5	2	2	3	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low | Low | Medium | High | Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**Projected**
HSIX_CHN	2	2	3	3			1	1	5
HSIX_VNM	3	3	2	2			1	1	5
River Basin	2	3	3	3	5	5	1	1	5

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	1				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Beilun Basin

Geography

Total drainage area (km^2)	840
No. of countries in basin	2
BCUs in basin	China (CHN), Viet Nam (VNM)
Population in basin (people)	116,863
Country at mouth	China, Viet Nam
Average rainfall (mm/year)	2,388

Governance

No. of treaties and agreements[1]	0
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	0
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
BLUN_CHN		1,261.11				
BLUN_VNM						
Total in Basin	1.06	1,261.11			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
BLUN_CHN	92.43	79.77	1.11	0.00	0	11.55	932.51	
BLUN_VNM								

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	92.43	79.77	1.11	0.00	0.00	11.55	790.88	8.73

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km²)
BLUN_CHN	1	0.85	99	139.23	0.51	0.00	100.00	0	6,807.43	0	0.00
BLUN_VNM	0	0.15	18	138.68	1.10			0	1,910.53	0	0.00
Total in Basin	1	1.00	117	139.15	0.58	0.00	84.81	0	6,063.69	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
BLUN_CHN	1	1	2		5		4		2	5	3	2	1	3	2
BLUN_VNM					5				2	4	3	5	1	2	1
River Basin	1	1	2	4	5		4		2	5	3	2	1	3	2

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low | Low | Medium | High | Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
BLUN_CHN	2	3	1	1			1	1	3
BLUN_VNM									3
River Basin	2	3	1	1	4	5	1	1	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

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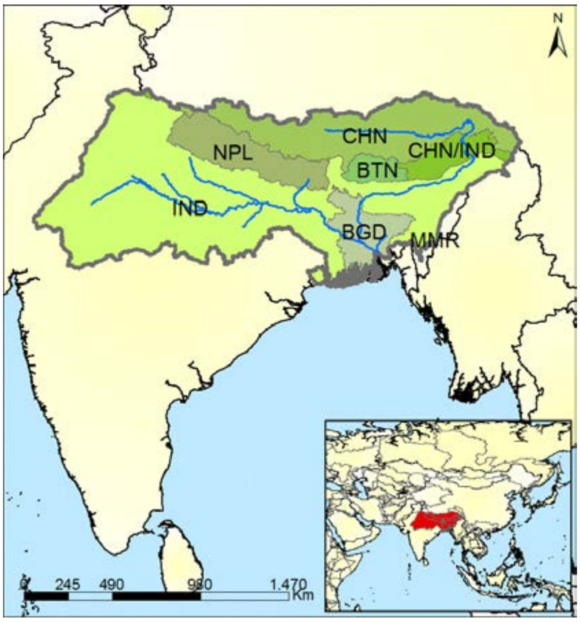
Ganges-Brahmaputra-Meghna Basin



Geography

Total drainage area (km^2)	1,652,367
No. of countries in basin	7
BCUs in basin	Arunachal Pradesh (CHN/IND), Bangladesh (BGD), Bhutan (BTN), China (CHN), India (IND), Myanmar (MMR), Nepal (NPL)
Population in basin (people)	704,221,090
Country at mouth	Bangladesh
Average rainfall (mm/year)	1,387

Governance

No. of treaties and agreements[1]	0
No. of RBOs and Commissions[2]	2

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	25
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
GANG_BGD		1,296.60			76.90	0.60
GANG_BTN		1,196.48				
GANG_CHN		506.82			1,641.70	27.52
GANG_CHN/IND		3,580.37				
GANG_IND		720.50			1,480.80	45.71
GANG_MMR						
GANG_NPL		1,078.23				
Total in Basin	1,420.98	859.97			3,199.40	73.82

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Water Withdrawals

BCU	Total (km³/year)	Irrigation (km³/year)	Livestock (km³/year)	Electricity (km³/year)	Manufacture (km³/year)	Domestic (km³/year)	Per capita (m³/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
GANG_BGD	69,546.63	62,745.29	225.90	2,098.07	1,215	3,262.62	494.23	
GANG_BTN	160.06	127.06	4.50	0.00	4	24.76	58.84	
GANG_CHN	725.42	613.54	38.24	0.00	0	73.64	386.09	
GANG_CHN/IND	173.97	117.96	5.53	1.25	0	49.22	168.36	
GANG_IND	422,355.42	342,858.61	1,634.40	8,129.41	48,189	21,543.52	798.88	
GANG_MMR								
GANG_NPL	7,122.92	6,292.46	109.87	1.96	104	614.46	244.13	
Total in Basin	500,084.42	412,754.93	2,018.43	10,230.69	49,512.15	25,568.22	710.12	35.19

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km²)
GANG_BGD	110	0.07	140,717	1,284.52	1.12	0.00	100.00	23	829.25	1	9.13
GANG_BTN	38	0.02	2,720	72.20	1.93	14.92	85.08	0	2,498.39	0	0.00
GANG_CHN	318	0.19	1,879	5.91	0.51	0.00	100.00	1	6,807.43	1	3.15
GANG_CHN/IND	70	0.04	1,033	14.85		0.00	100.00	0		0	0.00
GANG_IND	970	0.59	528,686	545.27	1.43	0.00	100.00	165	1,498.87	79	81.48
GANG_MMR	1	0.00	9	10.35	0.70			0	0.00	0	0.00
GANG_NPL	147	0.09	29,177	197.91	1.87	0.32	99.68	5	694.10	1	6.78
Total in Basin	1,652	1.00	704,221	426.19	1.23	0.07	99.93	194	1,347.53	82	49.63

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
GANG_BGD	2	4	3		5	5	3	3	3	3	3	2	5	3	5
GANG_BTN	1	1	2		5	3	3	3	3	5	5	4	5	3	4
GANG_CHN	2	1	2		5	2	4	3	3	5	5	2	1	3	3
GANG_CHN/IND	1	1	2			2	4	4	3	5	5		5	3	3

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GANG_IND	4	4	3		5	4	5	3	3	2	3	1	5	3	5
GANG_MMR					5	1			3	5	3	4	1	3	1
GANG_NPL	2	1	2		5	2	4	4	3	3	3	4	5	3	4
River Basin	4	3	3	5	5	4	4	4	3	3	3	2	5	3	5

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	**1.Environmental water stress**		**2.Human water stress**		**4.Nutrient pollution**		**16.Change in population density**		**11.Hydropolitical tension**
Basin BCU	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**Projected**
GANG_BGD	2	3	4	4			2	2	4
GANG_BTN	2	3	1	1			2	2	5
GANG_CHN	3	4	1	1			1	1	5
GANG_CHN/IND	2	2	1	1					5
GANG_IND	5	5	4	4			1	2	4
GANG_MMR									3
GANG_NPL	3	3	1	2			2	3	4
River Basin	4	4	4	4	5	5	1	2	4

TWAP RB Assessment results: Water System Linkages

Thematic group	**Lake Influence Indicator**	**Delta Vulnerability Index**			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	1	5	2	5	4

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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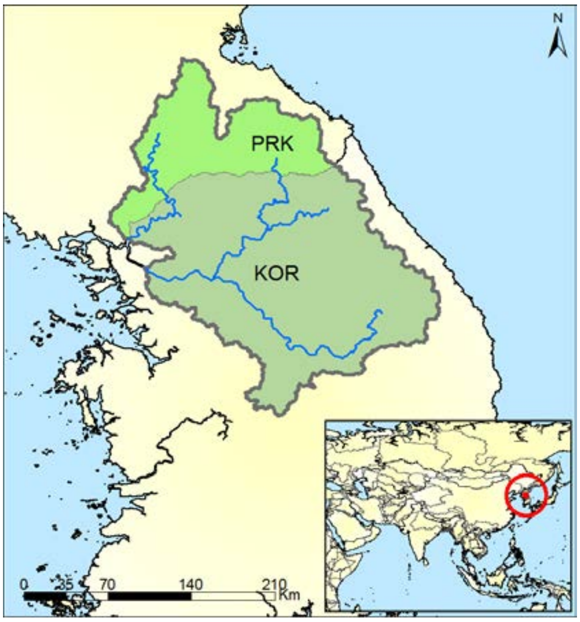
UNEP-DHI PARTNERSHIP
Centre on Water and Environment

Han Basin



Geography

Total drainage area (km^2)	33,378
No. of countries in basin	2
BCUs in basin	Dem People's Rep of Korea (PRK), Republic of Korea (KOR)
Population in basin (people)	17,758,016
Country at mouth	XXX
Average rainfall (mm/year)	1,328

Governance

No. of treaties and agreements[1]	0
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	3
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
HANX_KOR		575.88			63.90	0.37
HANX_PRK		629.28				
Total in Basin	19.74	591.28			63.90	0.37

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
HANX_KOR	8,419.69	1,295.23	40.22	1,715.91	1,932	3,436.25	509.20	
HANX_PRK	3,208.79	819.92	4.26	541.49	724	1,119.09	2,624.15	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	11,628.48	2,115.15	44.48	2,257.40	2,656.11	4,555.34	654.83	58.92

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km^2)
HANX_KOR	25	0.75	16,535	661.17		0.00	100.00	14	25,976.95	16	639.77
HANX_PRK	8	0.25	1,223	146.11		0.00	100.00	1	0.00	1	119.49
Total in Basin	33	1.00	17,758	532.02	0.44	0.00	100.00	15	24,188.22	17	509.31

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
HANX_KOR	2	4	2		1	3	5	3	4	5	3	1	5	1	2
HANX_PRK	2	1	2		5	2	4	2	4	5	3	4	3	3	2
River Basin	2	3	2	5	2	3	5	3	3	5	3	2	5	1	2

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low	Low	Medium	High	Very high

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Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**Projected**
HANX_KOR	3	3	4	3			1	1	3
HANX_PRK	3	3	1	1			1	1	4
River Basin	3	3	3	3	5	5	1	1	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	1				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Har Us Nur Basin

Geography

Total drainage area (km^2)	186,997
No. of countries in basin	3
BCUs in basin	China (CHN), Mongolia (MNG), Russian Federation (RUS)
Population in basin (people)	258,794
Country at mouth	Mongolia
Average rainfall (mm/year)	153

Governance

No. of treaties and agreements[1]	3
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	18
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
HRUN_CHN						
HRUN_MNG		21.95			5,240.80	50.96
HRUN_RUS		17.48			68.40	0.62
Total in Basin	4.09	21.86			5,309.20	51.58

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
HRUN_CHN								

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HRUN_MNG								
HRUN_RUS	0.78	0.00	0.26	0.00	0	0.52	189.84	
Total in Basin	324.26	222.13	14.83	76.97	0.99	9.34	1,252.98	7.93

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
HRUN_CHN	0	0.00	1	4.47	0.51			0	6,807.43	0	0.00
HRUN_MNG	183	0.98	254	1.60	1.58	89.99			2,286.00	0	0.00
HRUN_RUS	4	0.02	4	1.14	-0.12			0	14,611.70	0	0.00
Total in Basin	187	1.00	259	1.38	1.49	0.00	98.19	0	4,230.62	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
HRUN_CHN					5	5			3	2	1	2	1	2	1
HRUN_MNG	2	4	2		5	1	2	2	3	2	3	5	1	2	4
HRUN_RUS	1	5	1		4	1	3	1	3	3	3	2	1	2	2
River Basin	2	4	2	2	5	1	2	2	3	2	3	5	1	2	4

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low | Low | Medium | High | Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
HRUN_CHN									1
HRUN_MNG	3	3	5	5			2	3	3
HRUN_RUS	2	2	5	4			1	1	3
River Basin	3	3	4	5	2	2	2	2	3

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

TWAP RB Assessment results: Water System Linkages

Thematic group	**Lake Influence Indicator**	**Delta Vulnerability Index**			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	5				

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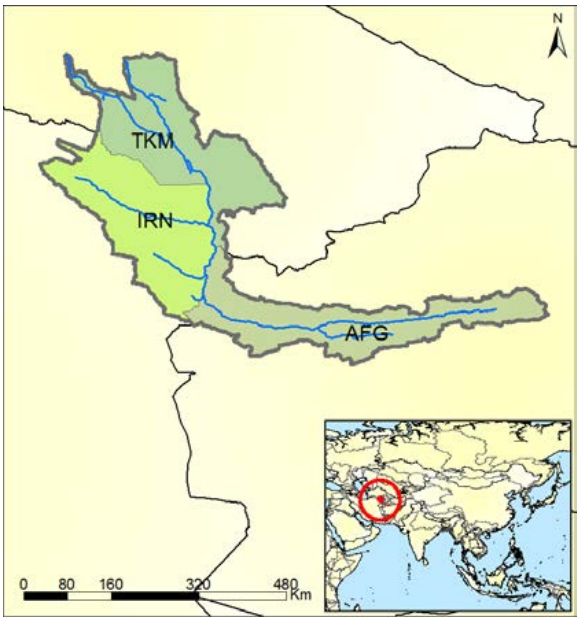
Hari/Harirud Basin



Geography

Total drainage area (km²)	119,096
No. of countries in basin	3
BCUs in basin	Afghanistan (AFG), Iran (Islamic Republic of) (IRN), Turkmenistan (TKM)
Population in basin (people)	5,667,828
Country at mouth	Turkmenistan
Average rainfall (mm/year)	240

Governance

No. of treaties and agreements[1]	1
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	1
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km³/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km³/year)	Av. Groundwater Discharge (km³/year)	Lake and Reservoir Surface Area (km²)	Lake and Reservoir Volume (km³)
HARI_AFG		127.45				
HARI_IRN		82.15				
HARI_TKM		36.86			197.10	0.83
Total in Basin	8.87	74.46			197.10	0.83

Water Withdrawals

BCU	Total (km³/year)	Irrigation (km³/year)	Livestock (km³/year)	Electricity (km³/year)	Manufacture (km³/year)	Domestic (km³/year)	Per capita (m³/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)

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HARI_AFG	4,562.53	4,506.82	4.01	0.00	26	26.17	2,856.43	
HARI_IRN	8,412.06	7,236.95	6.77	633.13	112	423.38	2,362.27	
HARI_TKM	6,159.80	6,024.38	3.49	0.00	54	77.63	12,089.08	
Total in Basin	19,134.39	17,768.16	14.27	633.13	191.66	527.18	3,375.96	215.77

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
HARI_AFG	39	0.33	1,597	41.07	2.58	0.00	100.00	1	678.35	0	0.00
HARI_IRN	41	0.34	3,561	87.16	1.18	0.00	100.00	1	4,763.30	0	0.00
HARI_TKM	39	0.33	510	12.95	1.20	0.00	100.00	0	7,986.70	1	25.42
Total in Basin	119	1.00	5,668	47.59	1.63	0.00	100.00	2	3,901.88	1	8.40

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
HARI_AFG	5	5	5		5	3	3	2	3	5	3		1	3	2
HARI_IRN	5	5	5		5	1	4	3	4	5	3	2	1	3	3
HARI_TKM	5	5	5		5	1	3	2	4	3	3	3	3	3	4
River Basin	5	5	5	3	5	2	3	3	2	4	3		2	4	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low | Low | Medium | High | Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
HARI_AFG	5	5	5	5			3	5	4
HARI_IRN	5	5	5	5			1	2	3
HARI_TKM	5	5	5	5			2	2	3

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

River Basin	5	5	5	5	4	4	2	3	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	1				

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Ili/Kunes He Basin

Geography

Total drainage area (km^2)	414,972
No. of countries in basin	3
BCUs in basin	China (CHN), Kazakhstan (KAZ), Kyrgyzstan (KGZ)
Population in basin (people)	5,183,543
Country at mouth	Kazakhstan
Average rainfall (mm/year)	276

Governance

No. of treaties and agreements[1]	3
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems
(No. of overlapping water systems)

Groundwater	
Lakes	4
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
ILIX_CHN		22.08				
ILIX_KAZ		60.73			18,944.40	126.59
ILIX_KGZ		61.65				
Total in Basin	22.71	54.74			18,944.40	126.59

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
ILIX_CHN	7,368.12	7,256.20	16.82	0.00	7	88.22	3,354.36	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

ILIX_KAZ	8,072.09	6,101.83	16.01	1,281.10	408	265.52	2,710.94	
ILIX_KGZ	431.28	423.33	1.23	0.00	0	6.72	46,037.80	
Total in Basin	15,871.48	13,781.36	34.06	1,281.10	414.51	360.46	3,061.90	69.87

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km^2)
ILIX_CHN	57	0.14	2,197	38.53	0.51	0.00	100.00	1	6,807.43	0	0.00
ILIX_KAZ	357	0.86	2,978	8.34	1.10	0.00	100.00	1	13,171.81	1	2.80
ILIX_KGZ	1	0.00	9	12.88	1.13			0	1,263.45	0	0.00
Total in Basin	415	1.00	5,184	12.49	1.05	0.00	99.82	2	10,453.32	1	2.41

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
ILIX_CHN	5	5	5		5	2	4	3	3	4	4	2	1	2	4
ILIX_KAZ	3	4	3		4	1	2	4	3	2	2	3	3	2	2
ILIX_KGZ	3		5		5	3			3	3	2		1	2	2
River Basin	3	4	4	3	4	2	3	4	3	3	3	3	3	3	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**Projected**
ILIX_CHN	5	5	5	5			1	1	4
ILIX_KAZ	5	5	4	4			1	2	2
ILIX_KGZ	5	5					2	2	2
River Basin	5	5	4	5	3	3	1	1	3

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

TWAP RB Assessment results: Water System Linkages

Thematic group	**Lake Influence Indicator**	**Delta Vulnerability Index**			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	5				

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Indus Basin

Geography

Total drainage area (km^2)	855,900
No. of countries in basin	7
BCUs in basin	Afghanistan (AFG), Aksai Chin (CHN/IND), China (CHN), India (IND), Jammu and Kashmir (CHN/IND/PAK), Nepal (NPL), Pakistan (PAK)
Population in basin (people)	189,911,699
Country at mouth	Pakistan
Average rainfall (mm/year)	489

Governance

No. of treaties and agreements[1]	4
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	19
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
INDU_AFG		277.38				
INDU_CHN		147.72			1,101.00	28.96
INDU_CHN/IND		39.05			94.62	1.49
INDU_CHN/IND/PAK		360.83			599.97	7.63
INDU_IND		529.78			505.90	7.91
INDU_NPL						
INDU_PAK		95.70			481.61	3.47
Total in Basin	176.38	206.08			2,783.10	49.46

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Water Withdrawals

BCU	Total (km³/year)	Irrigation (km³/year)	Livestock (km³/year)	Electricity (km³/year)	Manufacture (km³/year)	Domestic (km³/year)	Per capita (m³/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
INDU_AFG	9,299.45	8,657.09	23.08	10.91	396	212.25	875.06	
INDU_CHN	13.50	2.69	7.19	0.00	0	3.62	321.90	
INDU_CHN/IND	2.05	1.20	0.39	0.00	0	0.47	108.11	
INDU_CHN/IND/PAK	5,157.10	4,048.52	64.83	12.78	399	631.77	299.80	
INDU_IND	35,927.28	32,359.43	67.79	618.99	1,738	1,142.89	1,493.48	
INDU_NPL								
INDU_PAK	244,313.92	234,078.17	524.29	5,034.59	519	4,157.38	1,770.83	
Total in Basin	294,713.31	279,147.10	687.56	5,677.28	3,053.00	6,148.37	1,551.84	167.09

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km²)
INDU_AFG	71	0.08	10,627	149.02	2.58	0.00	100.00	4	678.35	2	28.05
INDU_CHN	82	0.10	42	0.51	0.51	0.00	100.00	0	6,807.43	0	0.00
INDU_CHN/IND	10	0.01	19	1.86				0		0	0.00
INDU_CHN/IND/PAK	184	0.21	17,202	93.49		0.00	100.00	2		2	10.87
INDU_IND	79	0.09	24,056	305.35	1.43	0.00	100.00	7	1,498.87	4	50.77
INDU_NPL	0	0.00	0	3.01	1.87			0	694.10	0	0.00
INDU_PAK	429	0.50	137,966	321.34	1.80	0.00	100.00	45	1,299.12	23	53.57
Total in Basin	856	1.00	189,912	221.89	1.49	0.00	99.99	58	1,173.10	31	36.22

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
INDU_AFG	4	3	3		5	1	4	3	3	4	2		4	3	2
INDU_CHN	3	1	2		5	1	3	3	3	5	3	2	1	3	3
INDU_CH	1	1	2			1	4	3	4	5	3		1	3	5

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

N/IND															
INDU_CHN/IND/PAK	2	2	2			2	4	4	3	5	5		5	3	3
INDU_IND	4	5	4		5	3	5	4	3	2	3	1	1	3	3
INDU_NPL					5				4	5	3	4	1	3	1
INDU_PAK	5	5	5		5	4	5	4	3	2	3	3	5	3	5
River Basin	4	5	5	4	5	3	4	4	3	3	3		4	3	4

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Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	**1.Environmental water stress**		**2.Human water stress**		**4.Nutrient pollution**		**16.Change in population density**		**11.Hydropolitical tension**
Basin BCU	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**Projected**
INDU_AFG	5	5	4	5			3	5	3
INDU_CHN	4	5	1	1			1	1	3
INDU_CHN/IND	5	5	1	1					3
INDU_CHN/IND/PAK	4	5	3	3					5
INDU_IND	5	5	5	5			1	2	4
INDU_NPL									4
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River Basin	5	5	5	5	4	4	2	3	4

TWAP RB Assessment results: Water System Linkages

Thematic group	**Lake Influence Indicator**	**Delta Vulnerability Index**			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	2	5	2	3	4

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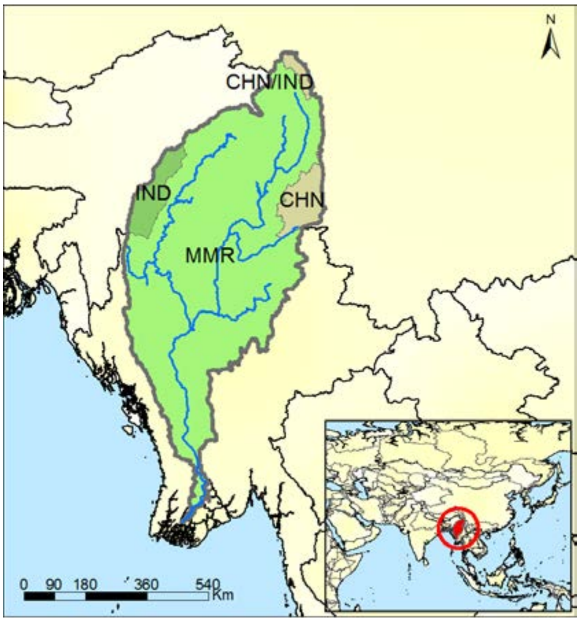
Irrawaddy Basin



Geography

Total drainage area (km^2)	375,475
No. of countries in basin	4
BCUs in basin	Arunachal Pradesh (CHN/IND), China (CHN), India (IND), Myanmar (MMR)
Population in basin (people)	28,582,552
Country at mouth	Myanmar
Average rainfall (mm/year)	1,887

Governance

No. of treaties and agreements[1]	0
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	4
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
IRWD_CHN		1,813.70				
IRWD_CHN/IND						
IRWD_IND		1,331.40			292.40	0.88
IRWD_MMR		1,458.16			263.00	2.22
Total in Basin	551.76	1,469.51			555.40	3.09

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)

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IRWD_CHN	338.05	297.19	4.29	0.00	0	36.57	183.96	
IRWD_CHN/IND								
IRWD_IND	232.36	64.68	10.00	18.86	39	100.28	80.87	
IRWD_MMR	8,077.66	7,235.52	92.75	57.90	197	494.58	338.38	
Total in Basin	8,648.07	7,597.39	107.05	76.75	235.45	631.43	302.56	1.57

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
IRWD_CHN	21	0.06	1,838	85.70	0.51	0.00	100.00	1	6,807.43	0	0.00
IRWD_CHN/IND	0	0.00	0	6.71				0		0	0.00
IRWD_IND	17	0.05	2,873	165.78	1.43	0.00	100.00	1	1,498.87	1	57.70
IRWD_MMR	337	0.90	23,872	70.91	0.70	0.00	100.00	10	0.00	10	29.70
Total in Basin	375	1.00	28,583	76.12	0.88	0.00	100.00	12	588.32	11	29.30

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Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
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IRWD_CHN/IND						1			1	5	3		1	3	1
IRWD_IND	1	1	2		5	1	4	3	3	5	3	1	1	2	3
IRWD_MMR	2	1	2		5	3	3	3	3	5	5	4	4	3	4
River Basin	2	1	2	3	5	3	3	3	3	5	5	3	4	2	4

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Very low | Low | Medium | High | Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress	2.Human water stress	4.Nutrient pollution	16.Change in population density	11.Hydropolitical tension

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
IRWD_CHN	2	3	1	1			1	1	5
IRWD_CHN/IN D									3
IRWD_IND	2	3	1	1			1	2	3
IRWD_MMR	2	3	1	1			1	1	5
River Basin	2	3	1	1	3	4	1	1	5

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1	5	2	4	3

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Jenisej/Yenisey Basin

Geography

Total drainage area (km^2)	2,504,604
No. of countries in basin	2
BCUs in basin	Mongolia (MNG), Russian Federation (RUS)
Population in basin (people)	7,802,049
Country at mouth	Russian Federation
Average rainfall (mm/year)	466

Governance

No. of treaties and agreements[1]	3
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	33
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
YNSY_MNG		62.95			2,800.50	379.49
YNSY_RUS		279.54			45,754.24	24,182.50
Total in Basin	630.67	251.81			48,554.74	24,561.99

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
YNSY_MNG								
YNSY_RUS	2,335.08	77.13	22.79	956.56	477	801.91	388.16	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	2,985.64	314.57	57.04	1,262.68	489.72	861.64	382.67	0.47

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
YNSY_MNG	318	0.13	1,786	5.32	1.58	28.92			2,286.00	0	0.00
YNSY_RUS	2,187	0.87	6,016	2.75	-0.12	0.00	100.00	9	14,611.70	7	3.20
Total in Basin	2,505	1.00	7,802	3.12	0.52	0.00	100.00	10	12,194.97	7	2.79

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
YNSY_MNG	2	2	2		5	2	3	1	3	4	3	5	1	2	2
YNSY_RUS	2	1	2		4	1	3	2	4	2	3	2	1	2	3
River Basin	2	1	2	1	5	1	3	2	3	3	3	3	1	2	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
YNSY_MNG	3	4	3	3			2	3	3
YNSY_RUS	4	5	1	1			1	1	3
River Basin	4	5	1	1	1	1	1	1	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	5				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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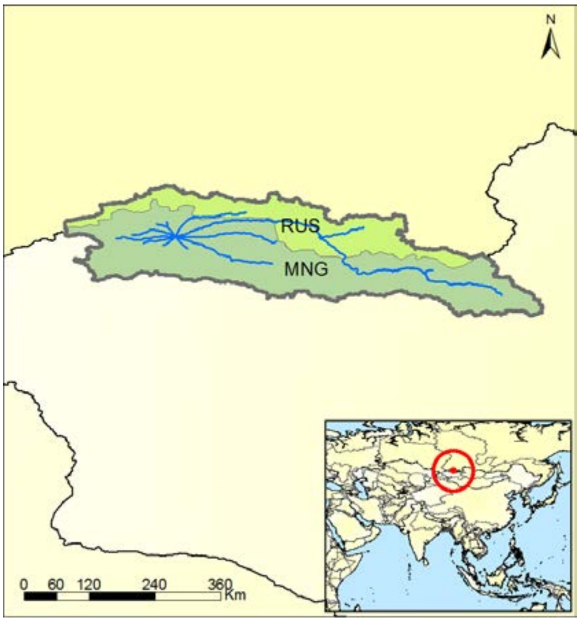
Lake Ubsa-Nur Basin



Geography

Total drainage area (km²)	70,328
No. of countries in basin	2
BCUs in basin	Mongolia (MNG), Russian Federation (RUS)
Population in basin (people)	89,240
Country at mouth	Mongolia
Average rainfall (mm/year)	199

Governance

No. of treaties and agreements[1]	2
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	2
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km³/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km³/year)	Av. Groundwater Discharge (km³/year)	Lake and Reservoir Surface Area (km²)	Lake and Reservoir Volume (km³)
LKUN_MNG		22.57			3,421.47	20.59
LKUN_RUS		30.72			68.93	0.59
Total in Basin	1.75	24.94			3,490.40	21.19

Water Withdrawals

BCU	Total (km³/year)	Irrigation (km³/year)	Livestock (km³/year)	Electricity (km³/year)	Manufacture (km³/year)	Domestic (km³/year)	Per capita (m³/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
LKUN_MNG								
LKUN_RUS	19.00	15.80	0.64	0.00	0	2.55	915.31	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	144.18	135.92	3.23	0.00	0.23	4.79	1,615.63	8.22

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
LKUN_MNG	50	0.71	68	2.43	1.58	80.04			2,286.00	0	0.00
LKUN_RUS	20	0.29	21	1.03	-0.12			0	14,611.70	0	0.00
Total in Basin	70	1.00	89	1.27	1.21	0.00	76.74	0	6,511.99	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
LKUN_MNG	2	3	2		5	2	1	1	3	5	3	5	1	2	4
LKUN_RUS	2	5	2		4	2	1	1	4	3	3	2	1	2	3
River Basin	2	4	2	2	5	2	1	1	3	4	3	4	1	2	4

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
LKUN_MNG	3	4	3	3			2	3	3
LKUN_RUS	3	3	3	3			1	1	3
River Basin	3	4	3	3	2	2	1	2	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	5				

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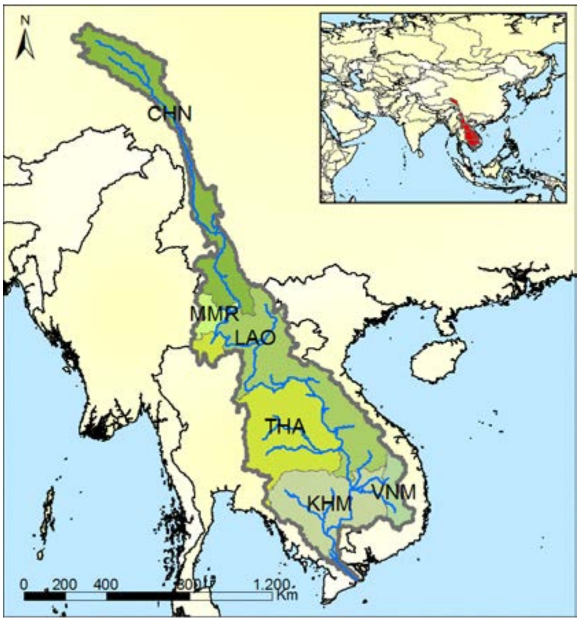
Mekong Basin



Geography

Total drainage area (km²)	773,231
No. of countries in basin	6
BCUs in basin	Cambodia (KHM), China (CHN), Lao People'S Democratic Republic (LAO), Myanmar (MMR), Thailand (THA), Viet Nam (VNM)
Population in basin (people)	58,742,817
Country at mouth	Viet Nam
Average rainfall (mm/year)	1,462

Governance

No. of treaties and agreements[1]	5
No. of RBOs and Commissions[2]	3

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	9
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km³/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km³/year)	Av. Groundwater Discharge (km³/year)	Lake and Reservoir Surface Area (km²)	Lake and Reservoir Volume (km³)
MEKO_CHN		402.06			247.00	2.72
MEKO_KHM		740.27			2,569.90	2.57
MEKO_LAO		848.38			443.80	6.19
MEKO_MMR		591.71				
MEKO_THA		510.91			946.60	9.24
MEKO_VNM		1,058.06				
Total in Basin	500.39	647.15			4,207.30	20.72

Water Withdrawals

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BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
MEKO_CHN	1,820.05	1,451.31	57.50	0.00	34	277.50	271.25	
MEKO_KHM	2,664.79	2,234.27	38.99	120.76	52	218.85	195.01	
MEKO_LAO	1,521.85	974.64	26.47	50.05	320	150.58	247.06	
MEKO_MMR	28.05	17.69	2.98	0.00	0	7.38	62.61	
MEKO_THA	13,198.09	10,509.17	63.16	674.56	491	1,460.53	530.97	
MEKO_VNM	10,326.79	8,403.42	19.30	26.05	406	1,472.14	1,495.84	
Total in Basin	29,559.62	23,590.49	208.39	871.42	1,302.34	3,586.98	503.20	5.91

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
MEKO_CHN	165	0.21	6,710	40.73	0.51	0.00	100.00	3	6,807.43	3	18.21
MEKO_KHM	154	0.20	13,665	88.68	1.14	0.14	99.86	2	1,007.57	0	0.00
MEKO_LAO	206	0.27	6,160	29.83	1.50	0.88	99.12	3	1,645.74	3	14.53
MEKO_MMR	22	0.03	448	20.62	0.70	0.00	100.00	0	0.00	0	0.00
MEKO_THA	188	0.24	24,856	132.11	0.71	0.00	100.00	4	5,778.98	13	69.09
MEKO_VNM	38	0.05	6,904	181.40	1.10	0.00	100.00	4	1,910.53	1	26.28
Total in Basin	773	1.00	58,743	75.97	0.94	0.12	99.88	16	3,854.40	20	25.87

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
MEKO_CHN	2	1	2		5	1	4	4	3	5	4	2	1	3	3
MEKO_KHM	2	2	2		5	4	3	5	4	2	3	2	5	3	5
MEKO_LAO	2	1	2		5	2	3	5	4	2	3	3	5	3	4
MEKO_MMR	1	1	2		5	2	3	4	3	5	4	4	1	3	3
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River Basin	2	2	2	3	5	3	3	5	4	2	3	3	4	3	5

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Very low	Low	Medium	High	Very high

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Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
MEKO_CHN	3	4	1	1			1	1	4
MEKO_KHM	2	2	2	2			2	3	4
MEKO_LAO	2	3	1	1			2	3	3
MEKO_MMR	2	2	1	1			1	1	4
MEKO_THA	3	3	4	4			1	1	3
MEKO_VNM	2	2	3	3			1	2	3
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Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
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Murgab Basin

Geography

Total drainage area (km^2)	93,335
No. of countries in basin	2
BCUs in basin	Afghanistan (AFG), Turkmenistan (TKM)
Population in basin (people)	1,843,826
Country at mouth	Turkmenistan
Average rainfall (mm/year)	250

Governance

No. of treaties and agreements[1]	1
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	1
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
MRGB_AFG		148.54				
MRGB_TKM		57.01			62.70	0.53
Total in Basin	8.65	92.68			62.70	0.53

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
MRGB_AFG	1,893.84	1,868.78	4.44	0.00	0	20.62	2,132.44	
MRGB_TKM	5,137.18	4,225.68	4.86	697.97	98	111.11	5,375.21	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	7,031.02	6,094.46	9.30	697.97	97.56	131.73	3,813.28	81.28

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km^2)
MRGB_AFG	39	0.42	888	22.92	2.58	0.00	100.00	1	678.35	0	0.00
MRGB_TKM	55	0.58	956	17.51	1.20	0.00	100.00	1	7,986.70	1	18.32
Total in Basin	93	1.00	1,844	19.75	1.83	0.00	100.00	2	4,466.51	1	10.71

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MRGB_AFG	4	3	3		5	1	3	1	3	5	3		1	3	2
MRGB_TKM	5	5	5		5	1	4	2	4	3	3	3	3	3	4
River Basin	5	5	5	2	5	1	3	2	3	4	3		2	4	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low | Low | Medium | High | Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
MRGB_AFG	5	5	5	5			3	5	4
MRGB_TKM	5	5	5	5			2	2	3
River Basin	5	5	5	5	3	3	3	5	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Ob Basin

Geography

Total drainage area (km^2)	3,042,475
No. of countries in basin	4
BCUs in basin	China (CHN), Kazakhstan (KAZ), Mongolia (MNG), Russian Federation (RUS)
Population in basin (people)	30,697,016
Country at mouth	Russian Federation
Average rainfall (mm/year)	515

Governance

No. of treaties and agreements[1]	4
No. of RBOs and Commissions[2]	2

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	88
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
OBXX_CHN		172.49				
OBXX_KAZ		52.33			10,030.00	58.49
OBXX_MNG						
OBXX_RUS		206.41			9,131.93	87.33
Total in Basin	499.00	164.01			19,198.20	146.10

Water Withdrawals

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[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

BCU	Total (km³/year)	Irrigation (km³/year)	Livestock (km³/year)	Electricity (km³/year)	Manufacture (km³/year)	Domestic (km³/year)	Per capita (m³/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
OBXX_CHN	2,857.68	2,837.79	7.05	0.00	0	12.85	7,364.87	
OBXX_KAZ	8,839.59	4,759.81	54.16	2,606.66	797	621.91	1,302.12	
OBXX_MNG								
OBXX_RUS	10,406.17	546.53	108.51	5,009.08	1,933	2,808.76	442.50	
Total in Basin	22,103.44	8,144.13	169.72	7,615.74	2,730.34	3,443.51	720.05	4.43

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km²)
OBXX_CHN	50	0.02	388	7.75	0.51	0.00	100.00	0	6,807.43	0	0.00
OBXX_KAZ	791	0.26	6,789	8.59	1.10	0.00	100.00	11	13,171.81	5	6.32
OBXX_MNG	1	0.00	3	2.01	1.58	63.25			2,286.00	0	0.00
OBXX_RUS	2,200	0.72	23,517	10.69	-0.12	0.00	100.00	25	14,611.70	1	0.45
Total in Basin	3,042	1.00	30,697	10.09	0.50	0.00	99.99	36	14,193.46	6	1.97

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
OBXX_CHN	2	5	3		5	2	4	3	3	2	3	2	1	2	3
OBXX_KAZ	2	2	3		4	3	3	3	3	2	4	3	3	2	2
OBXX_MNG					5	2			3	2	3	5	1	2	1
OBXX_RUS	2	1	2		4	2	3	3	4	3	4	2	2	2	3
River Basin	2	1	2	3	4	2	3	3	3	3	4	2	2	3	3

Indicators

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Very low | Low | Medium | High | Very high

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
OBXX_CHN	4	5	5	5			1	1	3
OBXX_KAZ	5	5	2	2			1	2	4
OBXX_MNG									3
OBXX_RUS	3	4	1	1			1	1	4
River Basin	4	5	1	1	3	2	1	1	4

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	2				

Indicators

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Oral/Ural Basin

Geography

Total drainage area (km^2)	211,721
No. of countries in basin	2
BCUs in basin	Kazakhstan (KAZ), Russian Federation (RUS)
Population in basin (people)	3,613,089
Country at mouth	Kazakhstan
Average rainfall (mm/year)	380

Governance

No. of treaties and agreements[1]	2
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	7
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
ORAL_KAZ		39.27			257.40	2.62
ORAL_RUS		58.92			351.90	3.96
Total in Basin	10.38	49.03			609.30	6.58

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
ORAL_KAZ	1,674.49	764.54	5.92	670.54	133	100.40	1,661.05	
ORAL_RUS	2,193.42	185.97	21.75	1,424.59	225	336.09	842.01	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	3,867.92	950.51	27.67	2,095.13	358.13	436.49	1,070.53	37.26

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km²)
ORAL_KAZ	90	0.43	1,008	11.15	1.10	0.00	100.00	3	13,171.81	0	0.00
ORAL_RUS	121	0.57	2,605	21.47	-0.12	0.00	100.00	4	14,611.70	1	8.24
Total in Basin	212	1.00	3,613	17.07	0.57	0.00	100.00	7	14,209.95	1	4.72

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ORAL_KAZ	2	3	3		4	2	3	2	3	3	3	3	1	2	3
ORAL_RUS	2	3	2		4	1	3	2	3	3	3	2	1	2	2
River Basin	2	3	2	3	4	1	3	2	3	3	3	3	1	3	3

Indicators

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Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
ORAL_KAZ	5	5	3	3			1	2	3
ORAL_RUS	5	5	3	3			1	1	3
River Basin	5	5	3	3	3	3	1	1	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	3				

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Pu Lun T'o Basin

Geography

Total drainage area (km^2)	48,675
No. of countries in basin	2
BCUs in basin	China (CHN), Mongolia (MNG)
Population in basin (people)	143,845
Country at mouth	China
Average rainfall (mm/year)	146

Governance

No. of treaties and agreements[1]	5
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	2
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
PULT_CHN		31.78			916.60	7.95
PULT_MNG		14.08				
Total in Basin	1.34	27.49			916.60	7.95

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
PULT_CHN	1,436.99	1,427.06	3.84	0.00	0	6.10	11,391.08	
PULT_MNG								

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	1,480.96	1,468.88	4.97	0.00	0.12	7.00	10,295.54	110.68

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
PULT_CHN	39	0.80	126	3.25	0.51			0	6,807.43	0	0.00
PULT_MNG	10	0.20	18	0.89	1.58	58.66			2,286.00	0	0.00
Total in Basin	49	1.00	144	2.96	0.62	0.00	0.00	0	6,469.02	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
PULT_CHN	3	5	5		5	3	4	3	3	2	1	2	1	2	4
PULT_MNG	2	5	3		5	3	3	2	3	2	3	5	1	2	3
River Basin	3	5	4	3	5	4	4	3	3	2	1	2	1	3	4

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
PULT_CHN	5	5	5	5			1	1	1
PULT_MNG	3	3	5	5			2	2	3
River Basin	5	5	5	5	3	3	1	1	1

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	5				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Red/Song Hong Basin

Geography

Total drainage area (km^2)	139,930
No. of countries in basin	3
BCUs in basin	China (CHN), Lao People'S Democratic Republic (LAO), Viet Nam (VNM)
Population in basin (people)	17,864,328
Country at mouth	Viet Nam
Average rainfall (mm/year)	1,515

Governance

No. of treaties and agreements[1]	0
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	1
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
REDX_CHN		560.19				
REDX_LAO		949.90				
REDX_VNM		1,006.75			259.50	1.82
Total in Basin	107.18	765.94			259.50	1.82

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
REDX_CHN	3,391.27	2,631.23	50.14	363.68	4	342.12	486.31	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

REDX_LAO	6.31	5.30	0.09	0.00	0	0.92	280.02	
REDX_VNM	10,199.92	1,973.79	41.95	403.62	4,401	3,379.53	938.49	
Total in Basin	13,597.49	4,610.33	92.18	767.30	4,405.12	3,722.57	761.15	12.69

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km²)
REDX_CHN	75	0.54	6,973	92.92	0.51	0.00	100.00	0	6,807.43	0	0.00
REDX_LAO	2	0.01	23	13.91	1.50			0	1,645.74	0	0.00
REDX_VNM	63	0.45	10,868	171.80	1.10	0.00	100.00	3	1,910.53	2	31.61
Total in Basin	140	1.00	17,864	127.67	0.83	0.00	99.87	3	3,821.73	2	14.29

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
REDX_CHN	2	2	2		5	1	4	4	3	5	5	2	1	3	2
REDX_LAO	1	1	2		5		2	5	2	5	3	3	1	3	1
REDX_VNM	2	2	2		5	2	3	5	3	4	5	5	1	3	5
River Basin	2	2	2	4	5	1	3	5	3	4	5	3	1	3	4

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
REDX_CHN	3	3	2	2			1	1	5
REDX_LAO	3	3	1	1					3
REDX_VNM	2	3	2	2			1	2	5
River Basin	3	3	2	2	5	5	1	1	5

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

TWAP RB Assessment results: Water System Linkages

Thematic group	**Lake Influence Indicator**	**Delta Vulnerability Index**			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	1	2	1	5	3

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Salween Basin

Geography

Total drainage area (km^2)	265,362
No. of countries in basin	3
BCUs in basin	China (CHN), Myanmar (MMR), Thailand (THA)
Population in basin (people)	7,851,021
Country at mouth	Myanmar
Average rainfall (mm/year)	1,196

Governance

No. of treaties and agreements[1]	0
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems
(No. of overlapping water systems)

Groundwater	
Lakes	8
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
SALW_CHN		376.47			174.10	2.15
SALW_MMR		1,022.64			311.50	1.88
SALW_THA		545.70				
Total in Basin	175.70	662.11			485.60	4.03

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
SALW_CHN	881.12	720.68	27.39	0.00	0	133.05	235.98	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

SALW_MMR	794.86	598.82	23.42	62.71	17	93.38	228.09	
SALW_THA	910.24	778.35	4.33	54.35	0	73.20	1,439.50	
Total in Basin	2,586.22	2,097.85	55.14	117.07	16.53	299.64	329.41	1.47

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km²)
SALW_CHN	137	0.52	3,734	27.30	0.51	0.00	100.00	2	6,807.43	3	21.94
SALW_MMR	109	0.41	3,485	31.87	0.70	0.00	100.00	1	0.00	1	9.15
SALW_THA	19	0.07	632	32.83	0.71	0.00	100.00	0	5,778.98	0	0.00
Total in Basin	265	1.00	7,851	29.59	0.65	0.00	100.00	3	3,702.99	4	15.07

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
SALW_CHN	2	1	2		5	1	4	2	2	5	5	2	1	3	2
SALW_MMR	2	1	2		5	2	3	2	3	5	5	4	1	3	3
SALW_THA	2	1	2		5	1	4	2	3	5	3	3	1	2	3
River Basin	2	1	2	3	5	2	3	3	3	5	5	3	1	2	2

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low | Low | Medium | High | Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
SALW_CHN	3	4	1	1			1	1	5
SALW_MMR	2	2	1	1			1	1	5
SALW_THA	3	3	1	1			1	1	3
River Basin	3	3	1	1	4	4	1	1	5

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TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

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Shu/Chu Basin

Geography

Total drainage area (km^2)	75,489
No. of countries in basin	2
BCUs in basin	Kazakhstan (KAZ), Kyrgyzstan (KGZ)
Population in basin (people)	2,077,259
Country at mouth	Kyrgyzstan
Average rainfall (mm/year)	275

Governance

No. of treaties and agreements[1]	1
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	4
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
SHUR_KAZ		46.12			82.60	0.54
SHUR_KGZ		114.70				
Total in Basin	4.68	62.00			82.60	0.54

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
SHUR_KAZ	1,677.63	1,598.67	3.76	0.00	38	37.68	5,041.62	
SHUR_KGZ	2,862.20	2,314.46	6.67	272.75	84	183.95	1,640.70	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
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Total in Basin	4,539.84	3,913.13	10.43	272.75	121.89	221.63	2,185.49	97.00

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km^2)
SHUR_KAZ	54	0.71	333	6.22	1.10			0	13,171.81	1	18.69
SHUR_KGZ	22	0.29	1,745	79.37	1.13	2.38	97.62	1	1,263.45	1	45.50
Total in Basin	75	1.00	2,077	27.52	1.90	2.00	81.98	1	3,171.05	2	26.49

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
SHUR_KAZ	3	5	4		4	2	3	3	3	2	2	3	1	2	2
SHUR_KGZ	4	5	5		5	3	4	2	3	2	2		5	2	5
River Basin	3	5	5	2	5	3	4	3	3	2	2		3	2	5

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low | Low | Medium | High | Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
SHUR_KAZ	5	5	5	5			1	2	2
SHUR_KGZ	5	5	5	5			2	2	3
River Basin	5	5	5	5	2	2	1	2	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	5				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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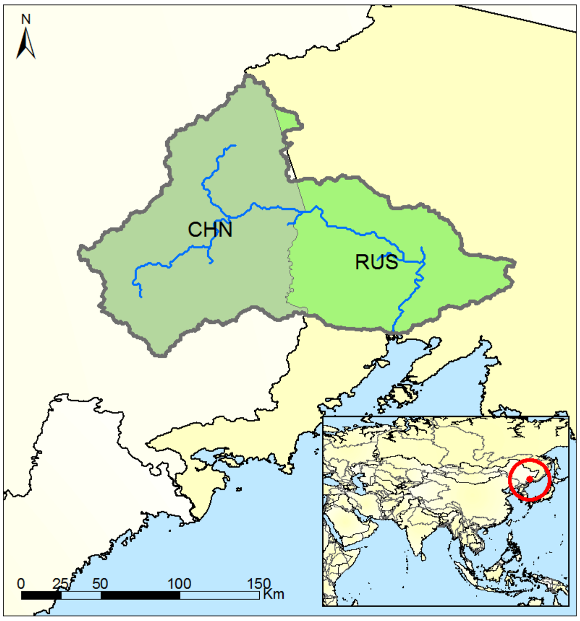
Sujfun Basin



Geography

Total drainage area (km^2)	16,820
No. of countries in basin	2
BCUs in basin	China (CHN), Russian Federation (RUS)
Population in basin (people)	501,469
Country at mouth	Russian Federation
Average rainfall (mm/year)	667

Governance

No. of treaties and agreements[1]	1
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	0
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
SUJF_CHN		97.51				
SUJF_RUS		175.29				
Total in Basin	2.46	146.23			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
SUJF_CHN	25.94	17.63	1.74	0.00	0	6.57	69.43	
SUJF_RUS	159.98	5.19	1.02	40.01	52	61.43	1,250.87	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	185.92	22.82	2.76	40.01	52.34	68.00	370.75	7.56

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km²)
SUJF_ CHN	10	0.60	374	37.27	0.51	0.00	100.00	0	6,807.43	0	0.00
SUJF_ RUS	7	0.40	128	18.82	-0.12	0.00	100.00	1	14,611.70	0	0.00
Total in Basin	17	1.00	501	29.81	0.43	0.00	100.00	1	8,797.88	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
SUJF_CHN	1	2	2		5	1	2	2	3	5	3	2	1	2	3
SUJF_RUS	1	1	2		4	4	1	2	4	3	3	2	1	2	3
River Basin	1	2	2	4	5	3	1	2	3	4	3	2	1	3	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
SUJF_CHN	3	3	3	3			1	1	3
SUJF_RUS	2	3	2	2			1	1	3
River Basin	2	3	2	2	4	4	1	1	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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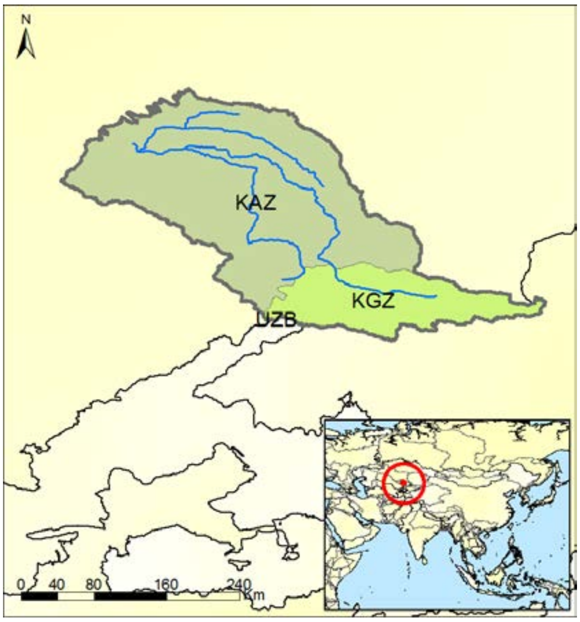
Talas Basin



Geography

Total drainage area (km^2)	45,426
No. of countries in basin	3
BCUs in basin	Kazakhstan (KAZ), Kyrgyzstan (KGZ), Uzbekistan (UZB)
Population in basin (people)	739,978
Country at mouth	Kazakhstan
Average rainfall (mm/year)	328

Governance

No. of treaties and agreements[1]	2
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	1
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
TALA_KAZ		101.05			82.10	0.16
TALA_KGZ		224.42				
TALA_UZB						
Total in Basin	6.01	132.38			82.10	0.16

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
TALA_KAZ	2,702.98	2,510.21	1.71	34.09	101	55.51	4,657.21	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

TALA_KGZ	661.93	644.29	2.37	0.00	0	15.27	4,148.16	
TALA_UZB								
Total in Basin	3,364.91	3,154.50	4.08	34.09	101.46	70.78	4,547.31	55.96

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km^2)
TALA_ KAZ	35	0.76	580	16.71	1.10	0.00	100.00	1	13,171.81	1	28.80
TALA_ KGZ	11	0.24	160	14.91	1.13	14.08	85.92	0	1,263.45	1	93.46
TALA_ UZB	0	0.00	0	16.50				0	1,878.09	0	0.00
Total in Basin	45	1.00	740	16.29	1.57	3.04	96.96	1	10,603.53	2	44.03

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
TALA_KAZ	3	4	5		4	3	4	2	3	2	2	3	1	2	2
TALA_KGZ	2	3	3		5	2	4	1	3	2	2		1	2	3
TALA_UZB					5				3	3	3	3	1	2	
River Basin	3	4	4	2	4	3	4	2	3	2	2		1	2	2

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**Projected**
TALA_KAZ	4	5	4	4			1	2	2
TALA_KGZ	5	5	3	3			2	2	2
TALA_UZB									3
River Basin	5	5	4	4	2	2	1	2	2

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

TWAP RB Assessment results: Water System Linkages

Thematic group	**Lake Influence Indicator**	**Delta Vulnerability Index**			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	1				

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Tarim Basin

Geography

Total drainage area (km^2)	1,097,723
No. of countries in basin	7
BCUs in basin	Afghanistan (AFG), Aksai Chin (CHN/IND), China (CHN), Jammu and Kashmir (CHN/IND/PAK), Kazakhstan (KAZ), Kyrgyzstan (KGZ), Tajikistan (TJK)
Population in basin (people)	10,321,989
Country at mouth	China
Average rainfall (mm/year)	70

Governance

No. of treaties and agreements[1]	1
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	33
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
TRIM_AFG						
TRIM_CHN		9.83			3,604.40	42.59
TRIM_CHN/IND		0.12			170.90	2.35
TRIM_CHN/IND/PAK		83.65				
TRIM_KAZ		209.25				
TRIM_KGZ		98.90				
TRIM_TJK		146.95				
Total in Basin	13.30	12.11			3,775.30	44.94

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
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Water Withdrawals

BCU	Total (km³/year)	Irrigation (km³/year)	Livestock (km³/year)	Electricity (km³/year)	Manufacture (km³/year)	Domestic (km³/year)	Per capita (m³/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
TRIM_AFG								
TRIM_CHN	50,997.97	50,528.36	63.09	34.73	0	371.80	5,041.56	
TRIM_CHN/IND	4.14	0.86	1.48	0.00	0	1.81	93.38	
TRIM_CHN/IND/PAK	2.95	0.00	0.15	0.00	0	2.80	41.32	
TRIM_KAZ	1.26	0.00	0.23	0.00	0	1.02	1,564.89	
TRIM_KGZ	123.57	110.24	2.56	0.00	0	10.77	1,382.30	
TRIM_TJK	0.38	0.00	0.08	0.00	0	0.30	643.70	
Total in Basin	51,130.27	50,639.46	67.59	34.73	0.00	388.49	4,953.53	384.53

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km²)
TRIM_AFG	0	0.00	0	0.54	2.58			0	678.35	0	0.00
TRIM_CHN	1,048	0.96	10,116	9.65	0.51	0.00	100.00	4	6,807.43	0	0.00
TRIM_CHN/IND	22	0.02	44	2.00				0		0	0.00
TRIM_CHN/IND/PAK	2	0.00	71	35.19				0		0	0.00
TRIM_KAZ	0	0.00	1	7.44				0	13,171.81	0	0.00
TRIM_KGZ	24	0.02	89	3.73	1.13			0	1,263.45	0	0.00
TRIM_TJK	1	0.00	1	0.61	1.28			0	1,036.58	0	0.00
Total in Basin	1,098	1.00	10,322	9.40	0.50	0.00	98.00	4	6,683.29	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
TRIM_AFG					5				4	5	3		1	4	1
TRIM_CHN	5	5	5		5	1	4	4	3	5	5	2	3	3	5
TRIM_CH	5	5	3			2	4	4	4	5	3		1	3	5

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

N/IND															
TRIM_CHN/IND/PAK	2	5	1				4	4	4	5	3		1	3	3
TRIM_KAZ	1	1	1		4	3	5	4	3	3	3	3	1	2	1
TRIM_KGZ	3	1	2		5	2	4	3	3	3	3		1	2	2
TRIM_TJK	1	1	1		5	1	4	4	3	3	3	5	1	2	1
River Basin	5	5	5	2	5	1	4	4	3	5	5	2	3	3	5

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Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
TRIM_AFG									4
TRIM_CHN	5	5	5	5			1	1	5
TRIM_CHN/IND	5	5	5	5					3
TRIM_CHN/IND/PAK	5	5	5	5					3
TRIM_KAZ	4	5	1	1					3
TRIM_KGZ	5	5	1	1			1	2	3
TRIM_TJK	5	5	1	1			1	1	3
River Basin	5	5	5	5	2	2	1	1	5

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	5				

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Tumen Basin

Geography

Total drainage area (km^2)	33,227
No. of countries in basin	3
BCUs in basin	China (CHN), Dem People's Rep of Korea (PRK), Russian Federation (RUS)
Population in basin (people)	2,601,640
Country at mouth	Russian Federation
Average rainfall (mm/year)	685

Governance

No. of treaties and agreements[1]	1
No. of RBOs and Commissions[2]	3

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	0
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
TUMN_CHN		159.83				
TUMN_PRK		213.98				
TUMN_RUS		213.41				
Total in Basin	6.09	183.18			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
TUMN_CHN	369.93	294.81	6.99	8.43	0	59.71	245.20	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

TUMN_PRK	257.94	191.16	2.30	64.48	0	0.00	236.68	
TUMN_RUS	16.60	3.35	0.23	0.00	4	8.80	5,331.04	
Total in Basin	644.47	489.31	9.52	72.90	4.23	68.51	247.72	10.59

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km^2)
TUMN _CHN	23	0.68	1,509	66.41	0.51	0.00	100.00	5	6,807.43	2	88.03
TUMN _PRK	10	0.31	1,090	104.91				0	0.00	1	96.26
TUMN _RUS	0	0.00	3	26.11	-0.12			0	14,611.70	0	0.00
Total in Basin	33	1.00	2,602	78.30	0.51	0.00	57.99	5	3,965.15	3	90.29

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
TUMN_CHN	2	2	2		5	2	3	2	3	5	4	2	1	2	3
TUMN_PRK	2	2	2		5	1	3	2	4	5	4	4	1	3	3
TUMN_RUS	1		2		4	5			4	3	4	2	1	2	4
River Basin	2	2	2	3	5	2	3	2	3	5	4	2	1	2	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**Projected**
TUMN_CHN	2	2	3	3			1	1	4
TUMN_PRK	3	3	2	2			1	1	4
TUMN_RUS	2	3					1	1	4
River Basin	3	3	3	3	4	4	1	1	4

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

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Volga Basin

Geography

Total drainage area (km^2)	1,411,749
No. of countries in basin	2
BCUs in basin	Kazakhstan (KAZ), Russian Federation (RUS)
Population in basin (people)	58,620,871
Country at mouth	Russian Federation
Average rainfall (mm/year)	644

Governance

No. of treaties and agreements[1]	3
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	25
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
VOLG_KAZ		61.53				
VOLG_RUS		194.54			23,893.30	165.91
Total in Basin	274.16	194.20			23,893.30	165.91

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
VOLG_KAZ	7.69	5.22	0.52	0.00	0	1.95	1,011.74	
VOLG_RUS	24,996.19	2,574.63	265.06	8,879.75	6,042	7,235.05	426.46	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	25,003.88	2,579.85	265.57	8,879.75	6,041.70	7,237.00	426.54	9.12

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km²)
VOLG_KAZ	1	0.00	8	5.14				0	13,171.81	0	0.00
VOLG_RUS	1,410	1.00	58,613	41.56	-0.12	0.00	100.00	74	14,611.70	17	12.05
Total in Basin	1,412	1.00	58,621	41.52	0.22	0.00	99.99	74	14,611.51	17	12.04

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
VOLG_KAZ	3	1	2		4	2	3	4	3	3	2	3	1	2	2
VOLG_RUS	2	1	2		4	2	4	4	4	3	2	2	4	2	3
River Basin	2	1	2	2	4	2	4	4	3	3	2	2	4	3	3

Indicators

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Very low | Low | Medium | High | Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
VOLG_KAZ	5	5	1	1					2
VOLG_RUS	4	4	2	2			1	1	2
River Basin	4	5	2	2	2	3	1	1	2

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	2	1	5	1	4

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

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Yalu Basin

Geography

Total drainage area (km^2)	62,295
No. of countries in basin	2
BCUs in basin	China (CHN), Dem People's Rep of Korea (PRK)
Population in basin (people)	5,875,342
Country at mouth	China
Average rainfall (mm/year)	884

Governance

No. of treaties and agreements[1]	0
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	5
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
YALU_CHN		335.94			234.75	1.55
YALU_PRK		423.46			237.25	1.56
Total in Basin	23.74	381.03			472.00	3.11

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
YALU_CHN	1,493.81	536.01	19.83	527.74	208	202.18	424.65	
YALU_PRK	542.90	529.94	5.52	7.44	0	0.00	230.28	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	2,036.72	1,065.95	25.35	535.18	208.06	202.18	346.65	8.58

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
YALU_CHN	32	0.51	3,518	110.89	0.51	0.00	100.00	5	6,807.43	4	126.09
YALU_PRK	31	0.49	2,358	77.12		0.00	100.00	4	0.00	9	294.39
Total in Basin	62	1.00	5,875	94.31	0.51	0.00	100.00	9	4,075.82	13	208.68

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
YALU_CHN	2	2	2		5	2	5	2	4	5	3	2	1	2	3
YALU_PRK	2	1	2		5	1	4	3	4	5	3	4	3	3	4
River Basin	2	1	2	4	5	2	5	3	3	5	3	3	2	2	4

Indicators

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Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
YALU_CHN	2	3	3	3			1	1	3
YALU_PRK	3	3	1	1			1	1	3
River Basin	2	3	2	2	4	4	1	1	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

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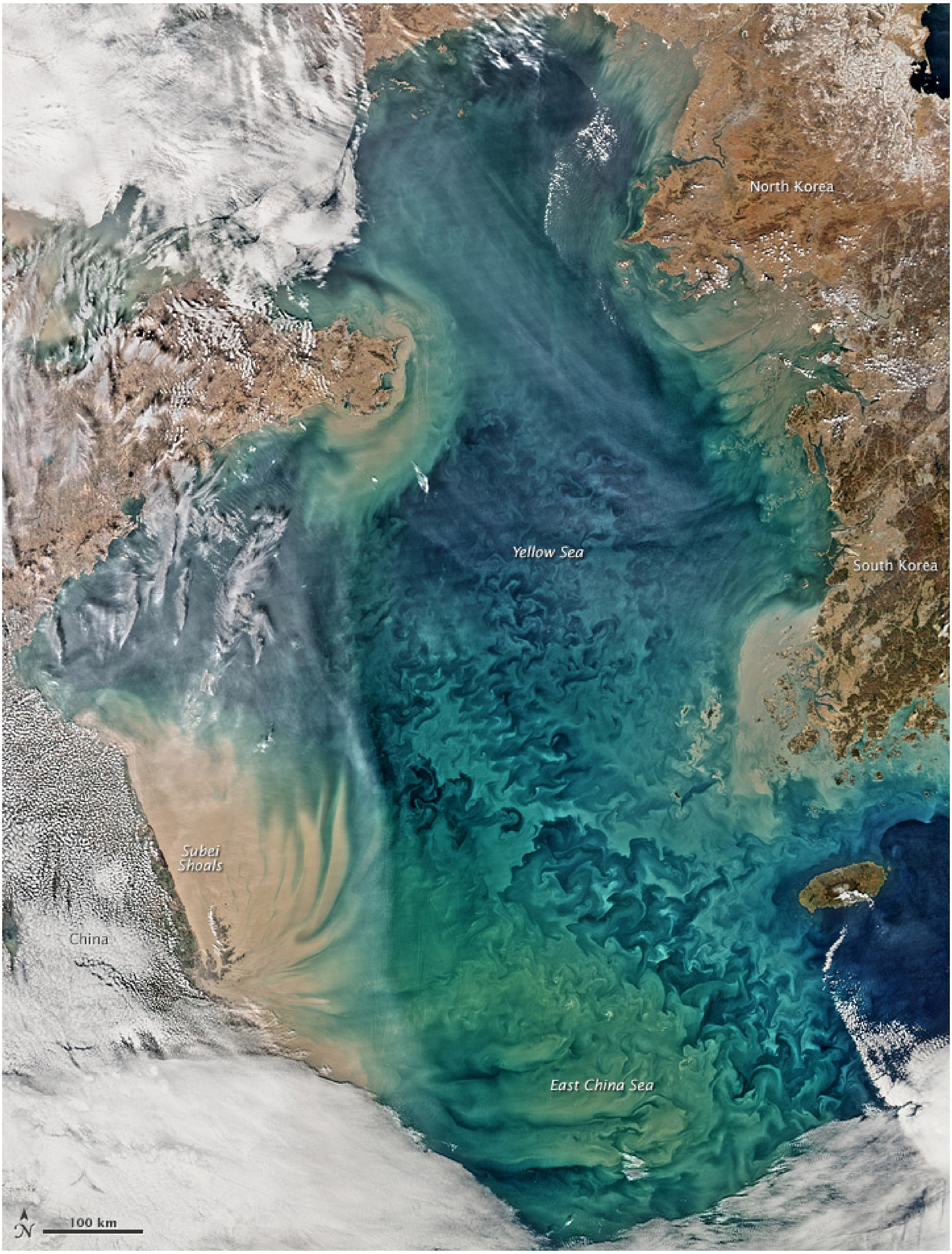
For more information on data sources, indicator calculation methodologies, limitations and more consult indicator metadata sheets available on TWAP RB Data portal on http://twap-rivers.org . To view sources of data included in this Factsheet download the Factsheet Reference file at http://twap-rivers.org/assets/Factsheet_template_with_references.pdf.

For more information on data sources, indicator calculation methodologies, limitations and more consult indicator metadata sheets available on TWAP RB Data portal on http://twap-rivers.org .

1. LME 36 – South China Sea
2. LME 47 – East China Sea
3. LME 48 – Yellow Sea
4. LME 49 – Kuroshio Current
5. LME 50 – Sea of Japan
6. LME 51 – Oyashio Current

Center for Marine Assessment and Planning, UCSB



NASA Earth Observatory

UNEP gef United Nations Educational, Scientific and Cultural Organization · Intergovernmental Oceanographic Commission

LME 36 – South China Sea

Bordering countries: Brunei Darussalam, China, Hong Kong, Indonesia, Macao, Malaysia, Philippines, Singapore, Taiwan, Viet Nam.
LME Total area: 5,660,985 km^2

List of indicators

LME overall risk

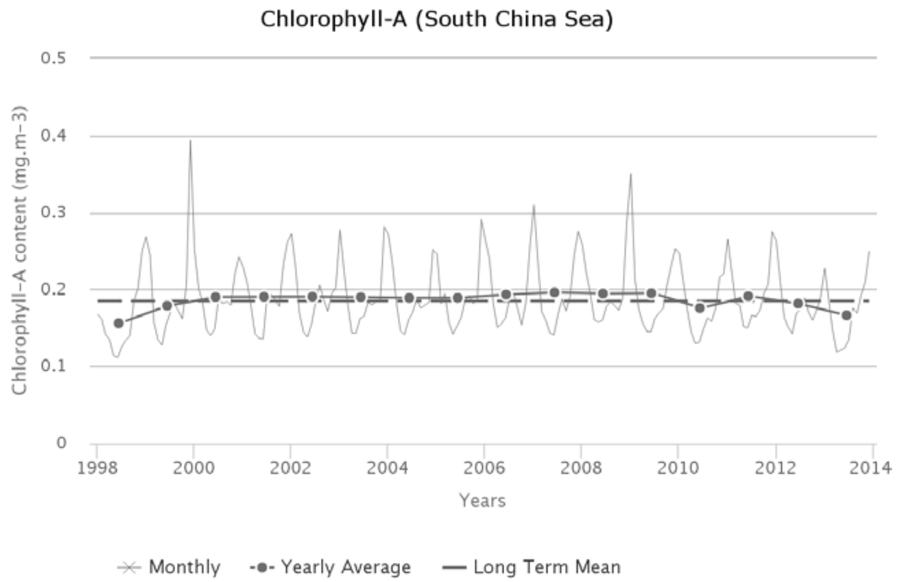
This LME falls in the cluster of LMEs that exhibit low to levels of economic development (based on the night light development index) and high pollution from plastic debris.
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very high.

Very low | Low | Medium | High | Very high

Productivity

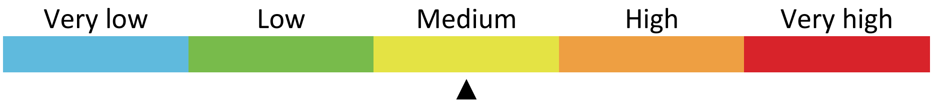
Chlorophyll-A

The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.270 $mg.m^{-3}$) in January and a minimum (0.139 $mg.m^{-3}$) during May. The average CHL is 0.185 $mg.m^{-3}$. Maximum primary productivity (295 $g.C.m^{-2}.y^{-1}$) occurred during 2007 and minimum primary productivity (263 $g.C.m^{-2}.y^{-1}$) during 2013. There is a statistically insignificant increasing trend in Chlorophyll of 2.96 % from 2003 through 2013. The average primary productivity is 285 $g.C.m^{-2}.y^{-1}$, which places this LME in Group 3 of 5 categories (with 1 = lowest and 5= highest).



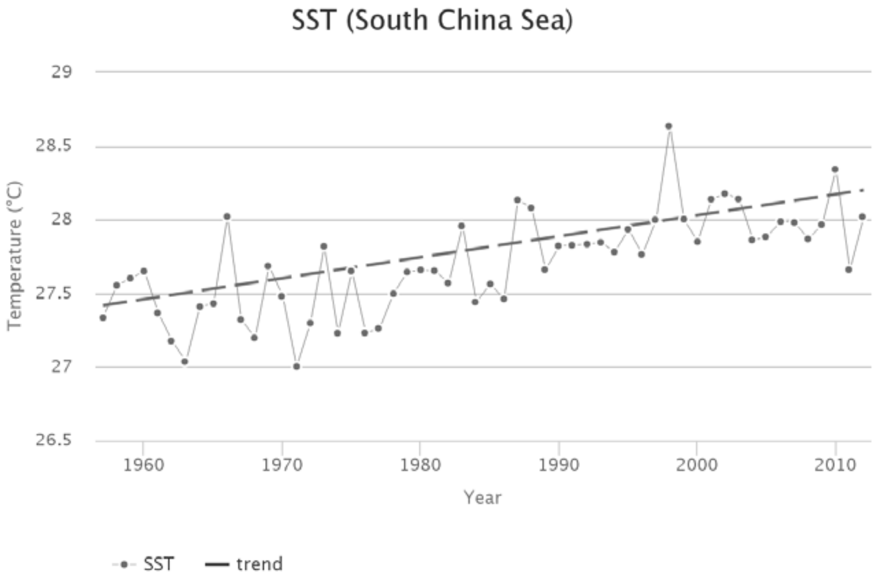
Very low | Low | Medium | High | Very high

Primary productivity



Sea Surface Temperature

From 1957 to 2012, the South China Sea #36 has warmed by 0.80°C, thus being on a threshold between Categories 2 and 3 (fast-to-moderate warming LME). The thermal history of the South China Sea is linked to that of the Gulf of Thailand LME #35. Interannual and decadal variability in the South China Sea are relatively small, <0.5°C. The observed stability of the South China Sea can be partly explained by the existence of the so-called South China Warm Pool (Li et al., 2007). The South China Warm Pool changes seasonally and inter-annually (He et al., 2000): It grows in summer; shrinks and retreats to the southwest in winter, and it is modulated inter-annually by the ENSO (El Niño-Southern Oscillation). The all-time maximum SST exceeded 28.6°C in 1998, coinciding with El Niño.

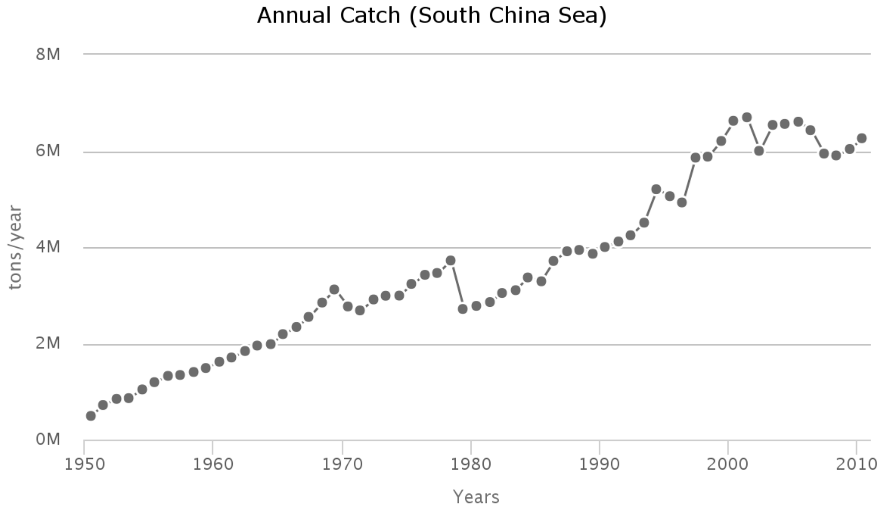


Fish and Fisheries

Reported landings from the South China Sea LME are in the order of 6 million t, although substantial uncertainty is associated with these high figures. The marine fisheries target groups that include tuna, billfishes, mackerels and sharks for the pelagic species, and a huge array of demersal fish and invertebrates, especially *penaeid* shrimps.

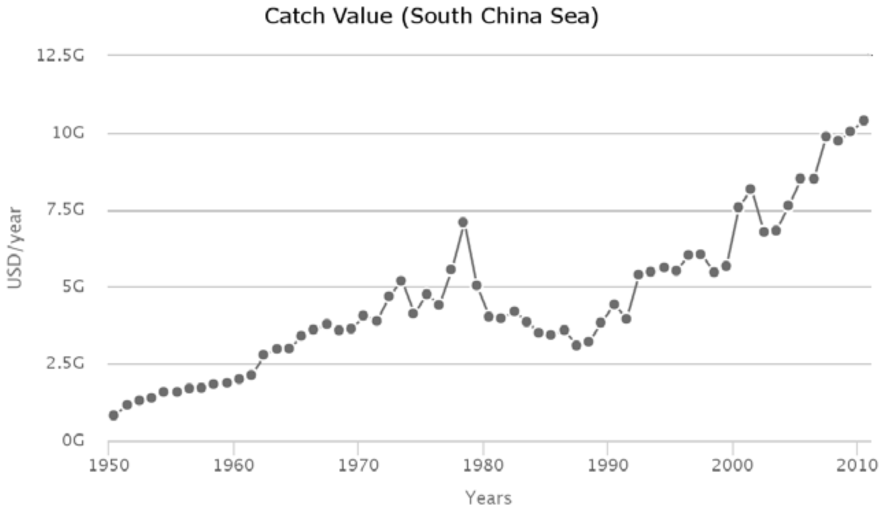
Annual Catch

The steady increase of the reported landings, from 490,000 t in 1950 to a peak of over 6 million t in 2001 is primarily due to a significant increase in the landings of unidentified fishes (included in 'mix group'), which account for two-thirds of the landings in recent years. In general, a high proportion of unidentified fishes in landings statistics is a symptom of deficiencies in a reporting system.



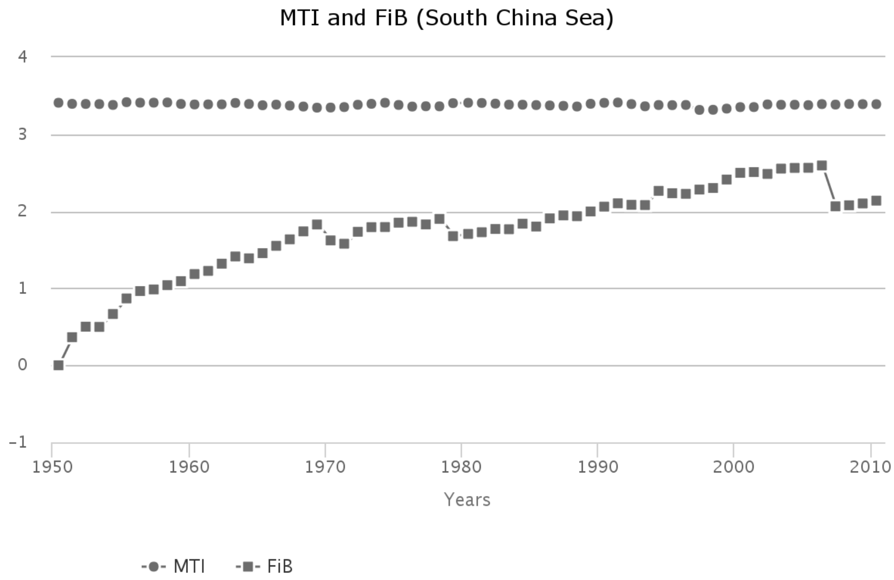
Catch value

Due to the large increase in the reported landings, the value of the landings also rose steadily, reaching around 10 billion US$ (in 2005 real US$) in the recent 5 years (2006 – 2010).



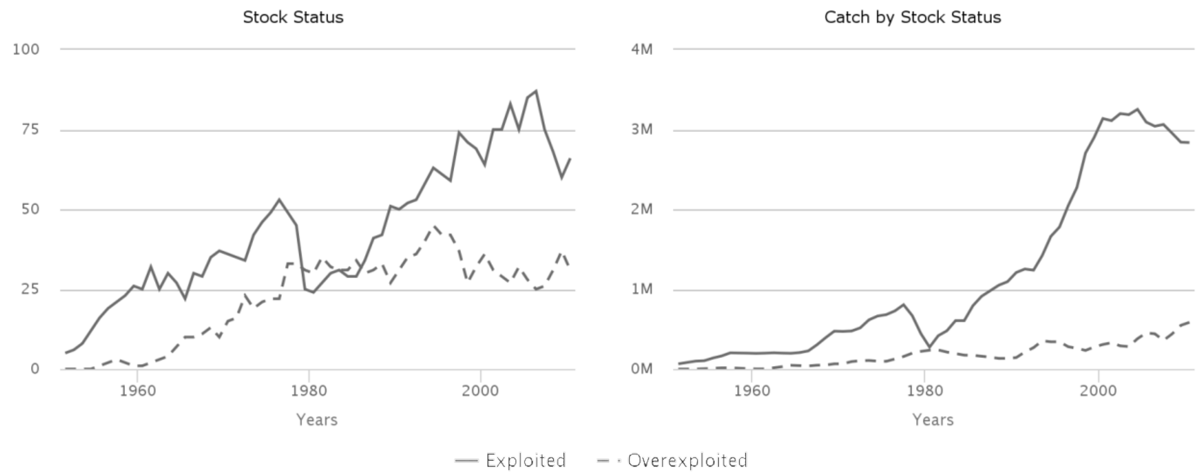
Marine Trophic Index and Fishing-in-Balance index

The trends of both MTI and the FiB index until the mid-1980s are suggestive of a 'fishing down' in the food web with a limited geographic expansion of fisheries. The trends of these indices from the mid-1980s on suggest that the landings statistics for the LME include either catches made outside the LME, which would also explain why the PPR for the fisheries in the LME is so high.



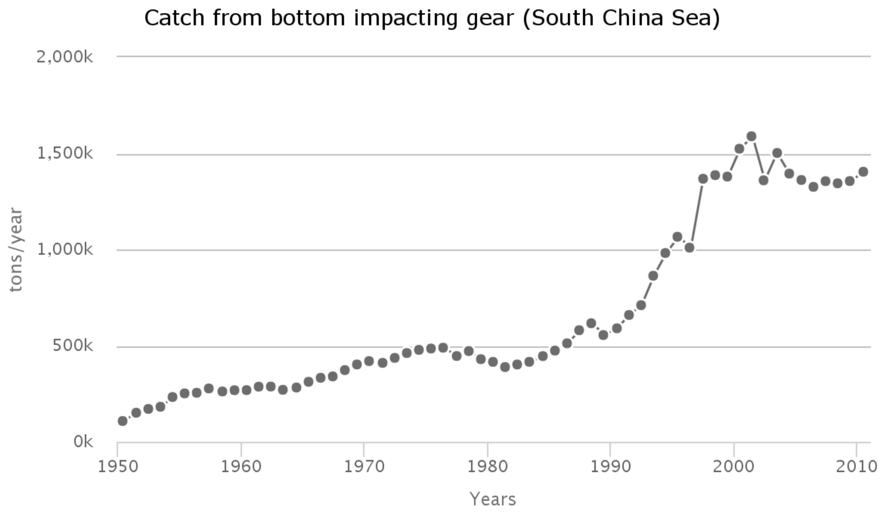
Stock status

The Stock-Catch Status Plots indicate that almost 40% of the stocks in the LME are collapsed or overexploited. However, the majority of the catches are supplied by fully exploited stocks. Such diagnosis is probably optimistic, and is again likely a result of the high degree of taxonomic aggregation in the underlying statistics.



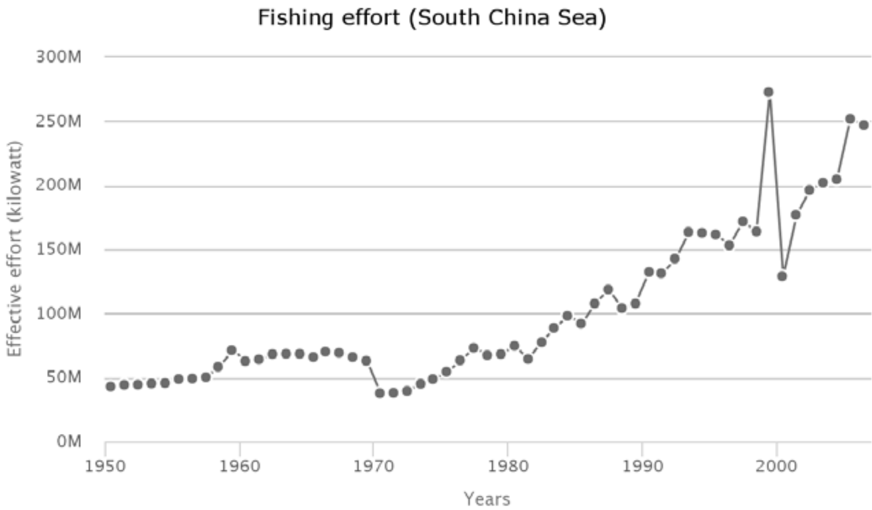
Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch fluctuated between 12 and 24% from 1950 to 2010. This percentage fluctuated around 22% in the recent decade.



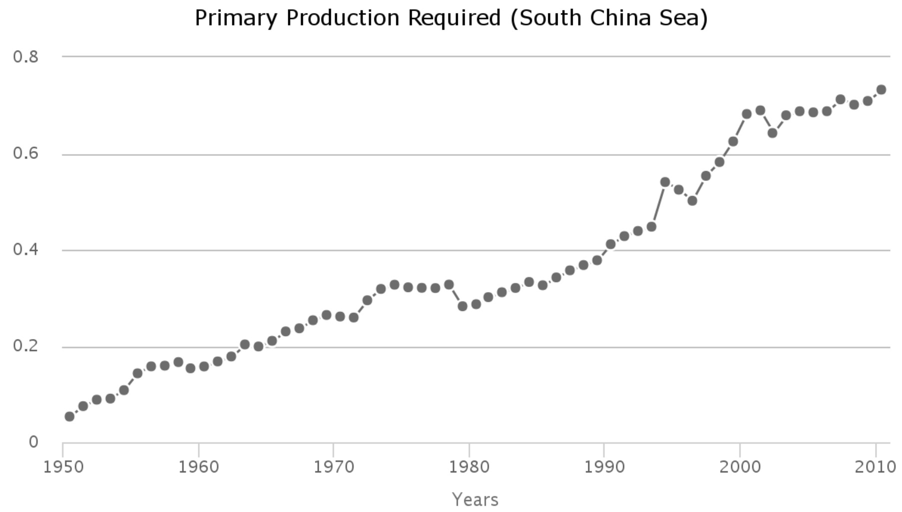
Fishing effort

The total effective effort continuously increased from around 45 million kW in the early 1950s to its peak at 270 million kW in 1999.



Primary Production Required

The primary production required (PPR) to sustain the reported landings in this LME is increasing with the reported landings, and since 2000, it is over 60% of the observed primary production, yet another indication that the reported landings from this LME may be unrealistically high.



Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans. An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was very high. (level 5 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a “current trends” scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was low (2). According to the Global Orchestration scenario, this increased to high in 2030 and remained high in 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was very high (5). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
5	2	5	5	4	5	5	4	5

Legend:

Very low | Low | Medium | High | Very high

POPs

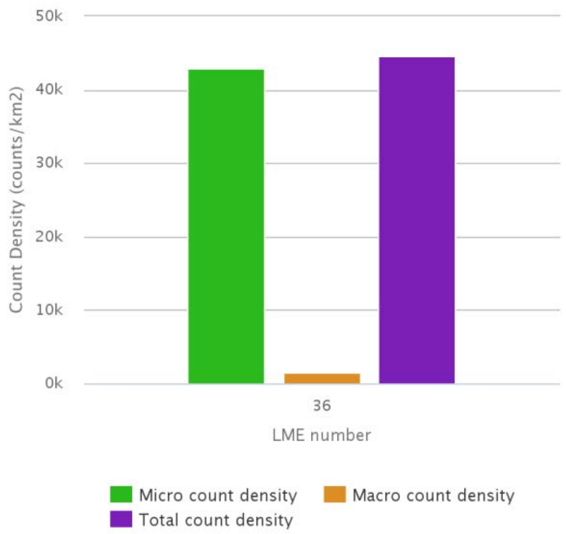
This LME includes Vietnam and Southern China. Twelve samples at 11 locations are available. Average concentrations (ng.g^{-1} of pellets) were high for DDT (176, range 1-558 ng.g^{-1}), moderate for PCBs (97, range 8-757 ng.g^{-1}), and minimal for HCHs (1.2, range 0.2-208 ng.g^{-1}). These averages correspond to risk categories 4, 3, and 1, respectively, of the five risk categories (1 = lowest risk; 5 = highest risk). High concentrations of DDTs were recorded both for northern Vietnam (163 – 558 ng.g^{-1}) and southern China including Hong Kong. Dominance of DDT over the degradation products (DDD and DDE) indicates current usage of DDT pesticide. DDT application for Malaria control could explain high DDTs concentrations in northern Vietnam and Haikou Bay (China), which have a tropical climate. Another possibility is illegal use of DDT pesticide for agricultural fields. In Hong Kong, the application of DDT to antifouling agents for boats is suspected. High DDTs concentrations were recorded even in the more recent samples. Source identification is highly recommended. Although the average PCBs concentration is moderate, the latest sample from Hong Kong showed an extremely high concentration (757 ng.g^{-1}), corresponding to risk category 5. This level may require regulatory and/or remediation action for food security.

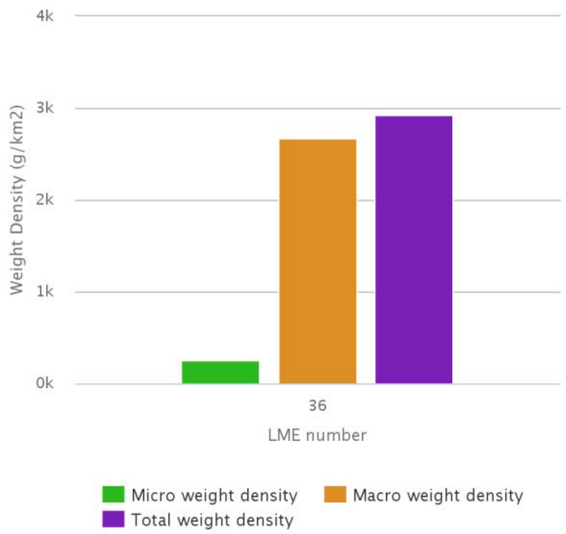
	PCBs		DDTs		HCHs	
Locations	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk
12	97	3	176	4	1.2	1

Legend: Very low, Low, Medium, High, Very high

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with the highest plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The high values are due to relative importance of these sources in this LME. The abundance of floating plastic in this category is estimated to be on average over 400 times higher that those LMEs with lowest values. There is limited evidence from sea-based direct observations and towed nets to support this conclusion.





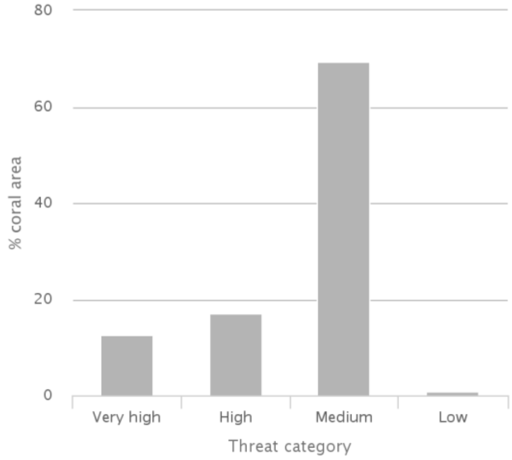
Ecosystem Health

Mangrove and coral cover

0.2% of this LME is covered by mangroves (US Geological Survey, 2011) and 0.42% by coral reefs (Global Distribution of Coral Reefs, 2010).

Reefs at risk

This LME has a present (2011) integrated threat index (combining threat from overfishing and destructive fishing, watershed-based and marine-based pollution and damage) of 241. 12% of coral reefs cover is under very high threat, and 17% under high threat (of the 5 possible threat categories, from low to critical). When combined with past thermal stress (between 1998 and 2007), these values increase to 19% and 24% for very high and high threat categories respectively. By year 2030, 26% of coral cover in this LME is predicted to be under very high to critical level of threat from warming and acidification; this proportion increases to 35% by 2050.

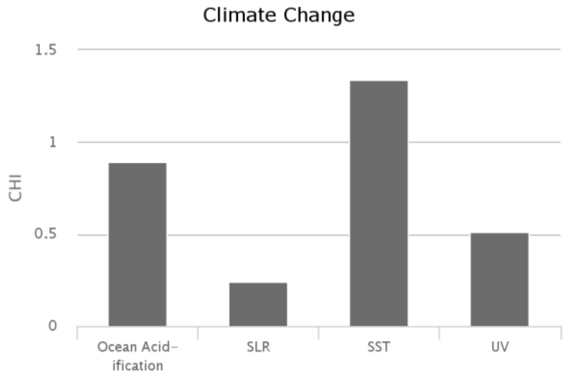


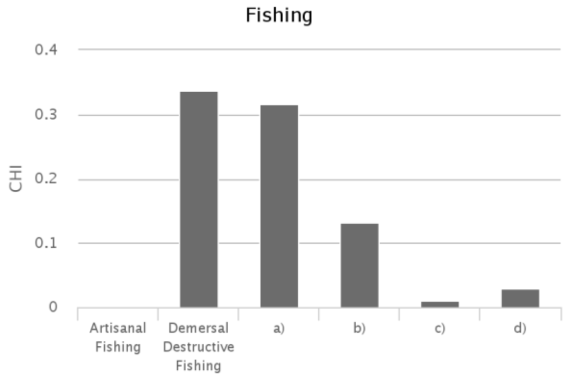
Marine Protected Area change

The South China Sea LME experienced an increase in MPA coverage from 1,504 km^2 prior to 1983 to 91,480 km^2 by 2014. This represents an increase of 5,981%, within the medium category of MPA change.

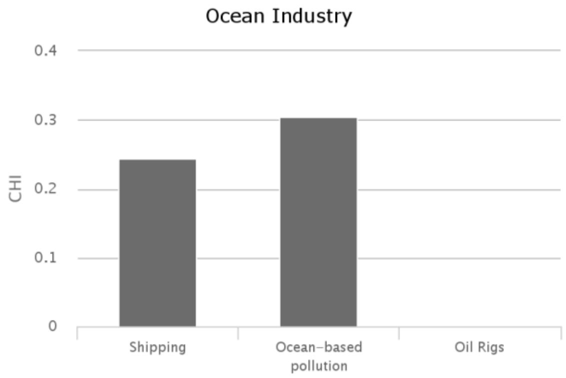
Cumulative Human Impact

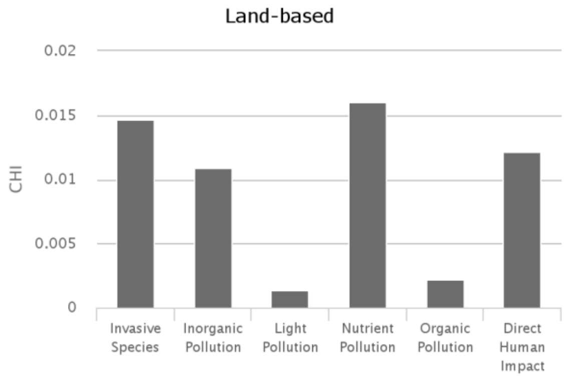
The South China Sea LME experiences well above average overall cumulative human impact (score 4.42; maximum LME score 5.22). It falls in risk category 5 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, all four connected to climate change have high average impact on the LME: ocean acidification (0.89; maximum in other LMEs was 1.20), UV radiation (0.51; maximum in other LMEs was 0.76), sea level rise (0.24; maximum in other LMEs was 0.71), and sea surface temperature (1.34; maximum in other LMEs was 2.16). Demersal destructive commercial fishing (0.34; maximum in other LMEs was 0.56) and demersal non-destructive high-bycatch (0.32; maximum in other LMEs was 0.60) also had high impact. Other key stressors include commercial shipping, ocean based pollution, and demersal non-destructive low-bycatch commercial fishing.

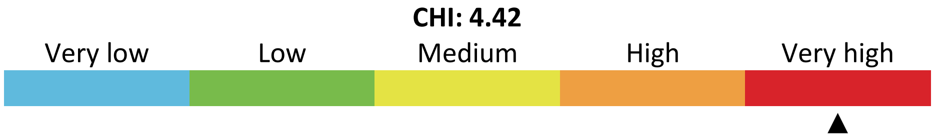




a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing

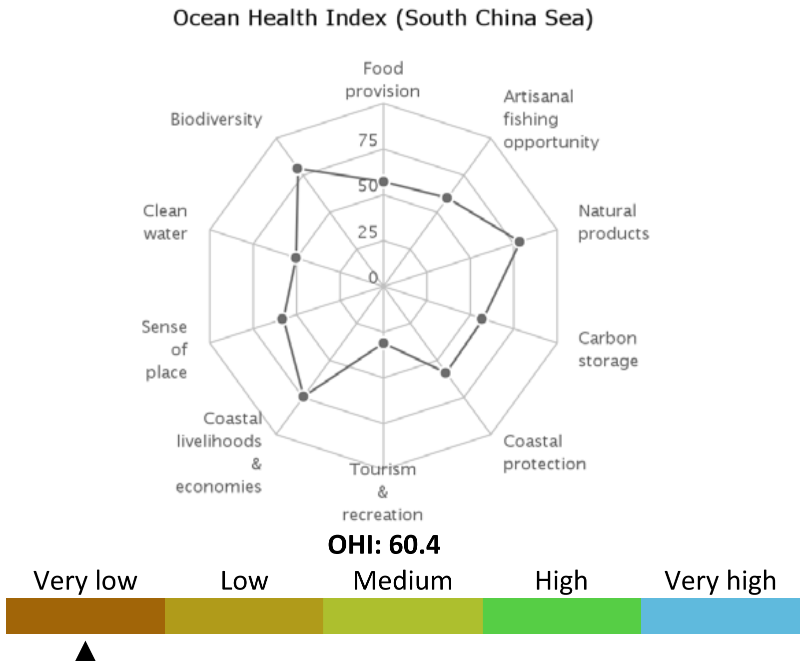






Ocean Health Index

The South China Sea LME scores below average on the Ocean Health Index compared to other LMEs (score 63 out of 100; range for other LMEs was 57 to 82). This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 increased 1 point compared to the previous year, due in large part to changes in the score for coastal economies. This LME scores lowest on food provision, coastal protection, carbon storage, tourism & recreation, sense of place and clean waters goals and highest on artisanal fishing opportunities. It falls in risk category 5 of the five risk categories, which is the highest level of risk (1 = lowest risk; 5 = highest risk).



Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 765 002 km^2. A current population of 271 695 thousand in 2010 is projected to decrease to 213 297 thousand in 2100, with a density of 355 persons per km^2 in 2010 decreasing to 279 per km^2 by 2100. About 47% of coastal population lives in rural areas, and is projected to increase in share to 58% in 2100.

Total population		Rural population	
2010	2100	2010	2100
271,695,309	213,297,270	127,398,450	123,833,770

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 14% of the LME's coastal dwellers. This LME places in the low-risk category based on percentage and in the very high-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
37,747,161

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the very high-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $10 287 million for the period 2001-2010. Fish protein accounts for 28% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$234 946 million places it in the very high-revenue category. On average, LME-based tourism income contributes 12% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with high risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
10,286,720,935	27.5	234,946,000,000	12.1	0.8019

Legend: Very low, Low, Medium, High, Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the medium HDI and medium-risk category. Based on an HDI of 0.700, this LME has an HDI Gap of 0.300, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a very high-risk category (very low HDI) because of reduced income levels and population values from those estimated in a sustainable development scenario.

	HDI 2100	
HDI	SSP1	SSP3
0.7001	0.8818	0.5704

Legend: Very low, Low, Medium, High, Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (*e.g.* overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

Present day climate threat index of this LME is within the very high-risk (very high threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is very high. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and increases to high risk under a fragmented world development pathway.

2010		2100	
Climate Threat	Contemporary Threat	SSP1	SSP3
0.9091	0.5236	0.4234	0.6500

Legend:

Very low Low Medium High Very high

Governance

Governance architecture

This LME has two transboundary arrangements for fisheries (WCPFC and APFIC) where each cover high sea highly migratory tuna and tuna-like fisheries and the fisheries within national jurisdiction. There does not appear to be any formal connection between the two arrangements, possibly since they have different areas of competence. However, the arrangement for the Regional Seas Programme, the Coordinating Body of the Seas of South east Asia (COBSEA) covers both pollution and biodiversity , with linkages to the Partnership in Environmental Management for the Seas of East Asia (PEMSEA). However neither of these "within national jurisdiction" arrangements appears to be integrated with the other or with the tuna arrangement. Similarly, the specific biodiversity arrangement for turtles does not appear to be integrated with the other arrangements in the LME. No integrating mechanisms, such as an overall policy coordinating organization for the LME, could be found. There may be interaction amongst the arrangements through participation in each other's meetings, but this appears to be informal.

The overall scores for ranking of risk were:

Engagement	Completeness	Integration
68	50	0.1

Legend:

Very low Low Medium High Very high

LME 47 – East China Sea

Bordering countries: China, Japan, Korea, Taiwan.
LME Total area: 1,008,066 km^2

List of indicators

LME overall risk

This LME falls in the cluster of LMEs that exhibit medium to high numbers of collapsed and overexploited fish stocks, high levels of demersal non-destructive low bycatch fishing, as well as very high shipping pressure.

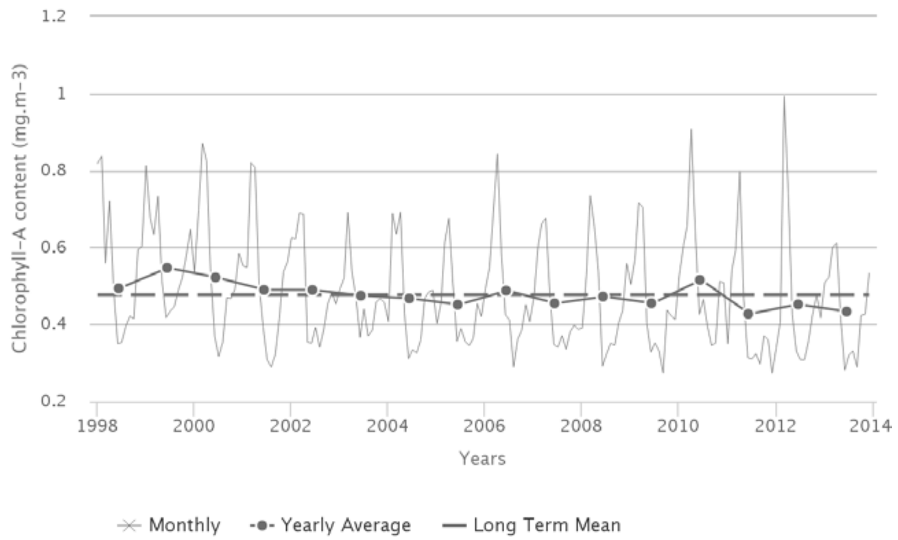
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very high.

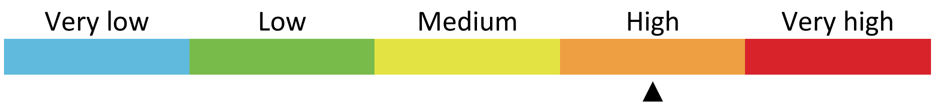
Productivity

Chlorophyll-A

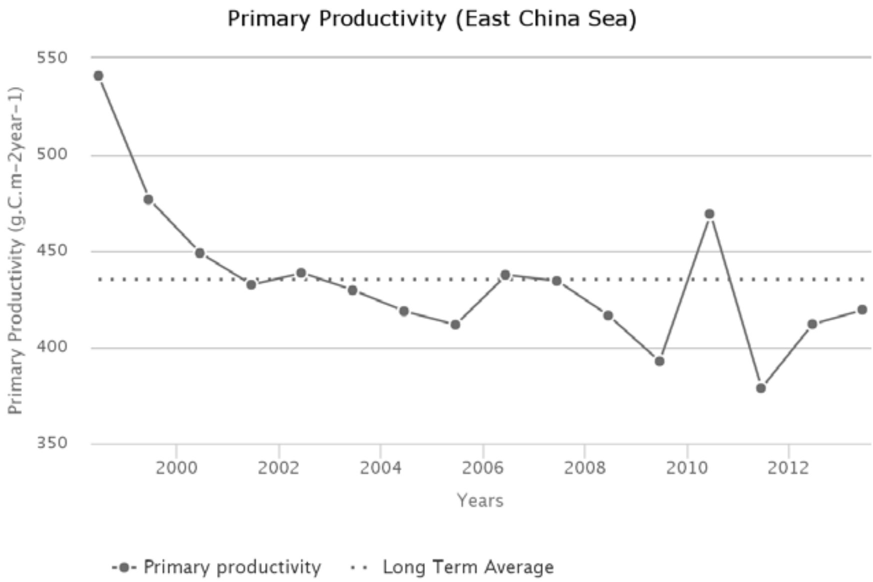
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.702 $mg.m^{-3}$) in March and a minimum (0.352 $mg.m^{-3}$) during August. The average CHL is 0.477 $mg.m^{-3}$. Maximum primary productivity (541 $g.C.m^{-2}.y^{-1}$) occurred during 1998 and minimum primary productivity (379 $g.C.m^{-2}.y^{-1}$) during 2011. There is a statistically insignificant increasing trend in Chlorophyll of 1.63 % from 2003 through 2013. The average primary productivity is 435 $g.C.m^{-2}.y^{-1}$, which places this LME in Group 4 of 5 categories (with 1 = lowest and 5= highest).

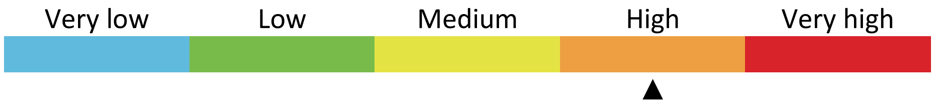
Chlorophyll-A (East China Sea)





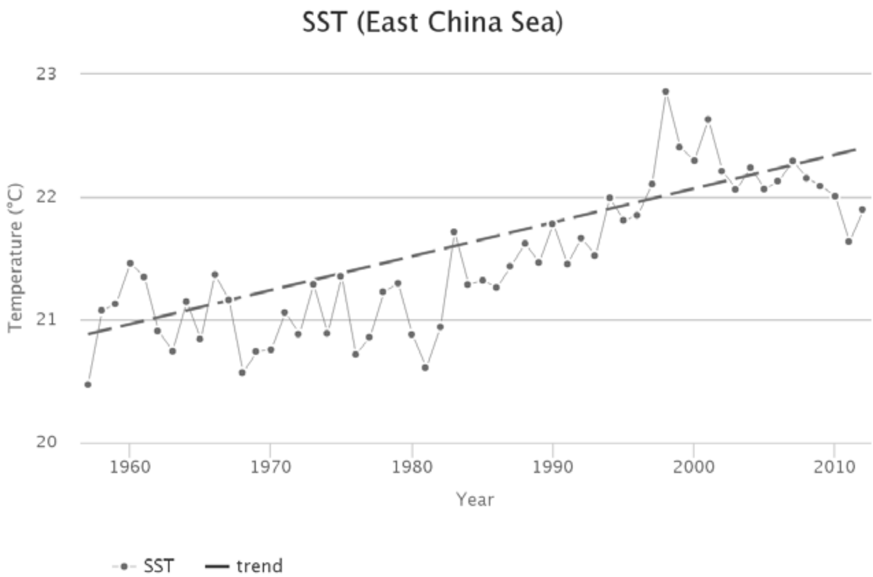
Primary productivity





Sea Surface Temperature

From 1957 to 2012, the East China Sea LME #47 has warmed by 1.57°C, thus belonging to Category 1 (super-fast warming LME). The East China Sea was the world's fastest warming LME between 1957 and 2012 owing to the super-fast warming between 1981 and 1998, when SST rose from 20.6 to 22.8, an unprecedented increase by 2.2°C in 17 years. After 1998, SST decreased down to 21.7°C in 2011, a 1.1°C drop in 13 years. Before 1981, the SST in this LME remained relatively stable since, at least, 1957, varying between 20.5°C and 21.5°C. The abrupt transition from the stable epoch of 1957-1981 to the super-fast warming of 1982-1998 is unparalleled in the World Ocean. The rapid warming of 1982-1998 might have been caused – or at least exacerbated – by the concurrent rapid industrialization and urbanization of China, leading to a 2°C warming of the Yangtze River basin and a 2°C increase of stream temperature of the Yangtze River, which empties into the East China Sea (Belkin, 2009; Belkin and Lee, 2014).

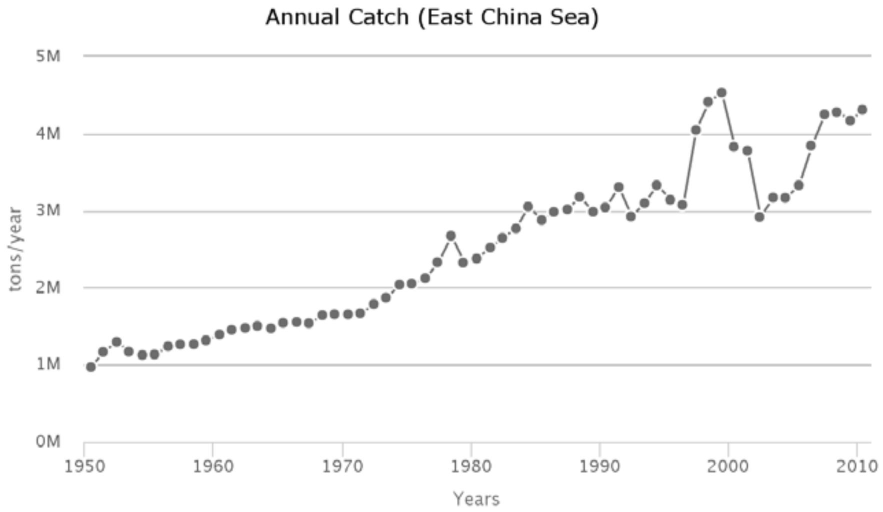


Fish and Fisheries

Fish and other living resources are heavily exploited in the East China Sea LME.

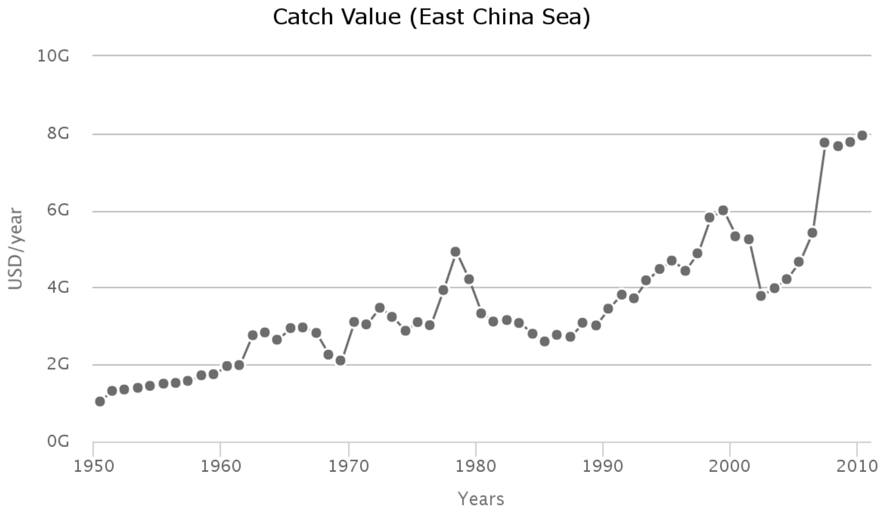
Annual Catch

Total reported landings have increased to about 4.5 million t in 1999, though there is a serious concern as to the validity of the underlying reported landings statistics.



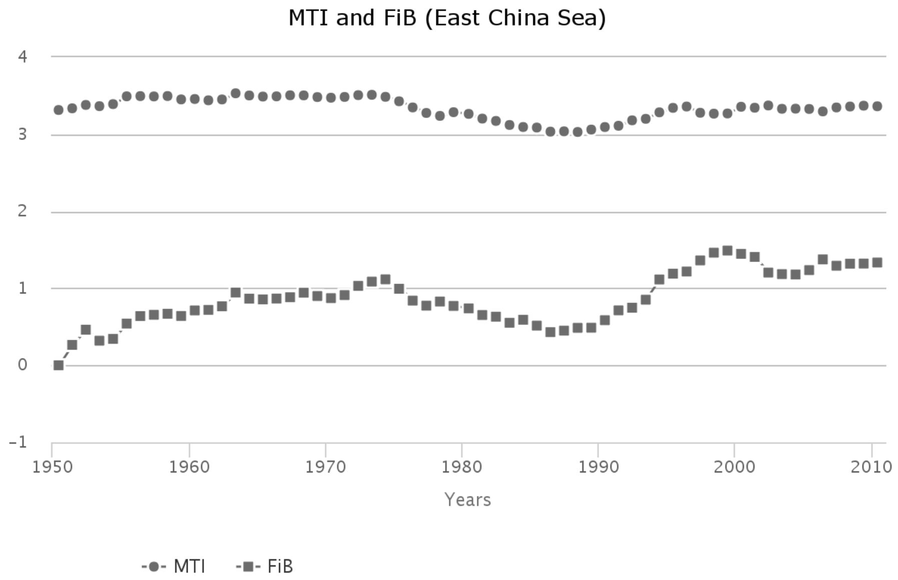
Catch value

Over the past decade, the value of the annual catch ranged between 3.7 billion and 8 billion US$ (in 2005 real US$) with a peak of just under 8 billion US$ (in 2005 real dollar) in 2010.



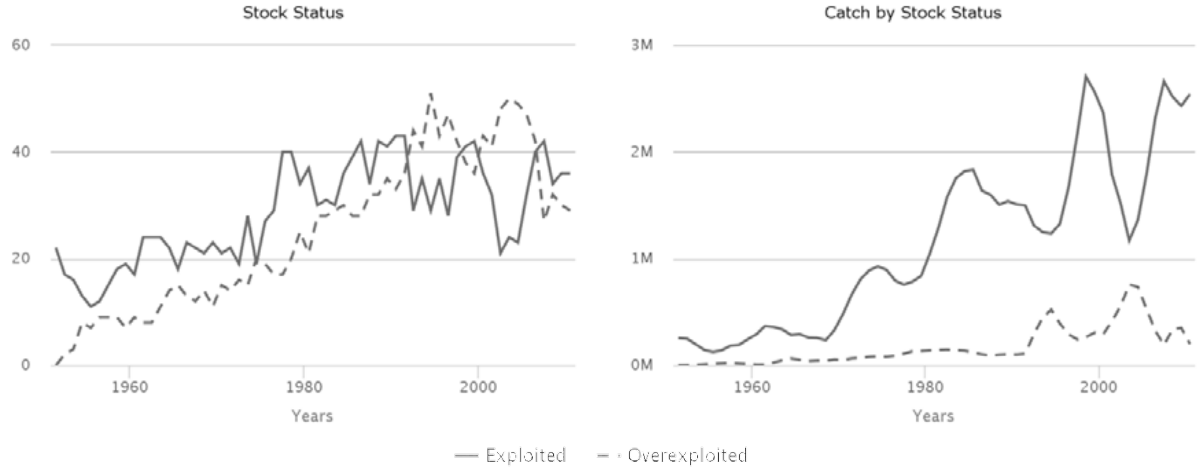
Marine Trophic Index and Fishing-in-Balance index

The concerns over the quality of the underlying landings statistics are also highlighted in the long-term trends of the MTI and the FiB index, with both indices showing a familiar pattern of overexploitation in the region up to the late 1980s, with a slow expansion of the fisheries implied by the increase in the FiB index, followed by a period of a decline in the mean trophic level or a 'fishing down' of the local food webs. In the 1990s, both indices show a significant increase, again suggesting that the underlying landings statistics include a large amount of catches from outside of the LME.



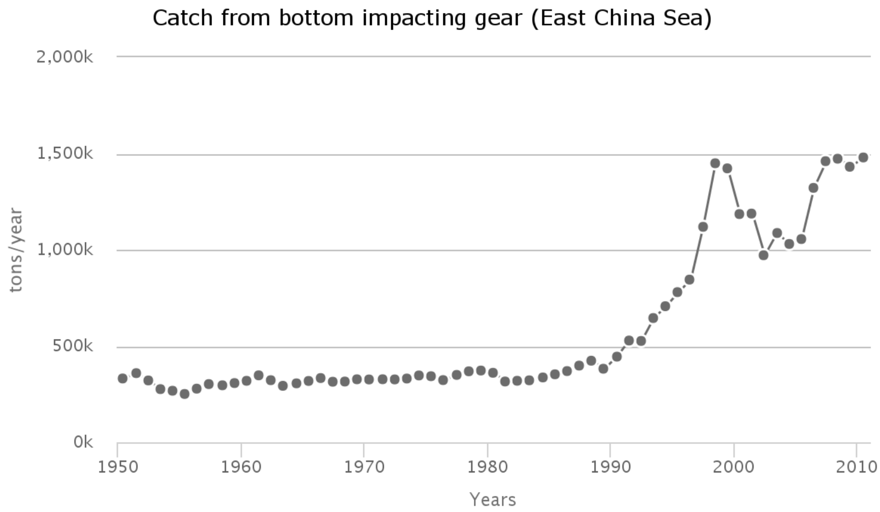
Stock status

The Stock-Catch Status Plots indicate that the number of collapsed and overexploited stocks have been rapidly increasing, now accounting for almost 50% of the commercially exploited stocks, yet, with 65% of the reported landings biomass from fully exploited stocks. Again, the quality of the underlying statistics must be questioned.



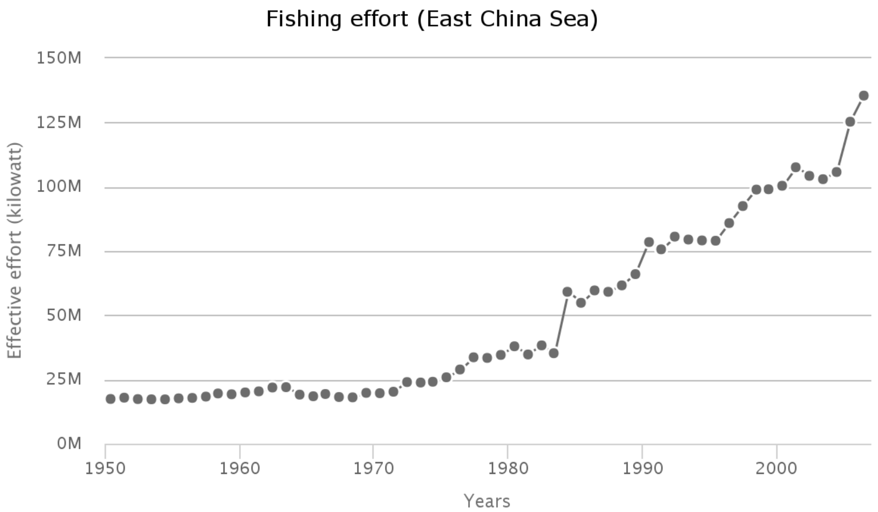
Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch decreased from 34% in the early 1950s to around 11% in 1983. Then, this percentage kept increasing and fluctuated around 34% in recent decade.



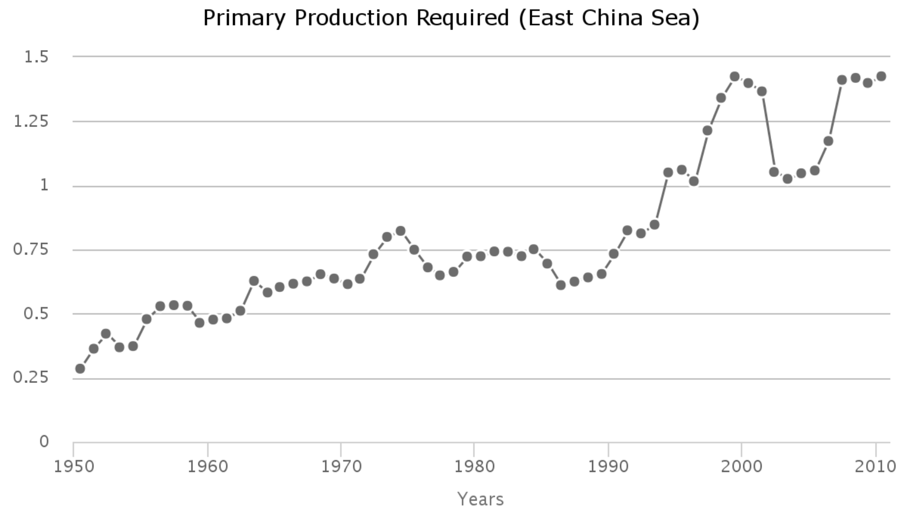
Fishing effort

The total effective effort continuously increased from around 17 million kW in the 1950s to its peak around 135 million kW in 2006.



Primary Production Required

In recent years, the primary production required (PPR) to sustain the reported landings in this LME has exceeded the observed primary production, which indicates serious problems with the underlying reported landings statistics, which probably include catches made outside the LME.



Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans.

An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was very high. (level 5 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was very high (5). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was very high (5). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
5	5	5	5	5	5	5	5	5

Legend:

Very low | Low | Medium | High | Very high

POPs

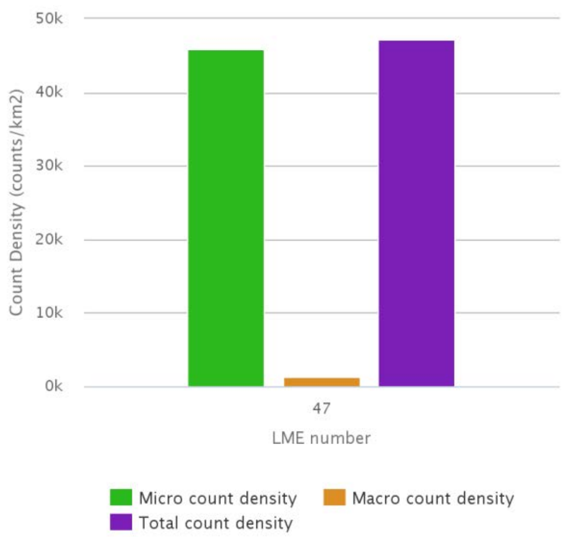
This LME includes the middle Chinese coast and southern coast of Korea. Five samples from 5 locations are available. Although the average PCBs concentration (ng.g^{-1} of pellets) is low (24, range 3-56) corresponding to category 2 of the 5 risk categories (1=lowest risk; 5= highest risk), moderate concentrations of PCBs (12 – 56 ng.g^{-1}) were recorded in the southern coast of Korea. This may be explained by legacy pollution. The average concentration of DDTs is 36 (range 11-80), corresponding to risk category 3. Samples from Shanghai show dominance of DDT over the degradation products, suggesting current inputs of DDTs. Agricultural application and/or antifouling paint may explain the moderate level of DDTs. HCH concentrations were minimal (0.1-0.7 ng.g^{-1}).

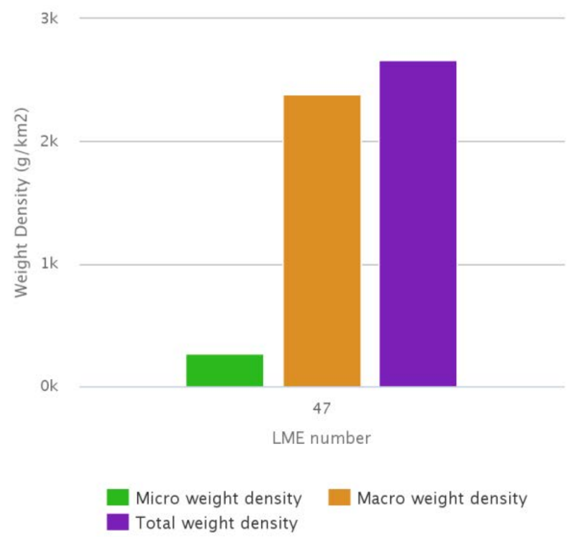
	PCBs		DDTs		HCHs	
Locations	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk
5	24	2	36	3	0.4	1

Legend: Very low, Low, Medium, High, Very high

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with the highest plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The high values are due to relative importance of these sources in this LME. The abundance of floating plastic in this category is estimated to be on average over 400 times higher that those LMEs with lowest values. There is moderate evidence from sea-based direct observations and towed nets to support this conclusion.





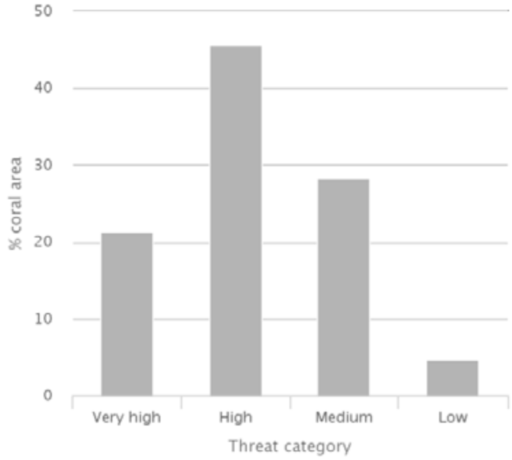
Ecosystem Health

Mangrove and coral cover

0.01% of this LME is covered by mangroves (US Geological Survey, 2011) and 0.06% by coral reefs (Global Distribution of Coral Reefs, 2010).

Reefs at risk

This LME has a present (2011) integrated threat index (combining threat from overfishing and destructive fishing, watershed-based and marine-based pollution and damage) of 283. 21% of coral reefs cover is under very high threat, and 46% under high threat (of the 5 possible threat categories, from low to critical). When combined with past thermal stress (between 1998 and 2007), these values increase to 61% and 29% for very high and high threat categories respectively. By year 2030, 33% of coral cover in this LME is predicted to be under very high to critical level of threat from warming and acidification; this proportion increases to 67% by 2050.

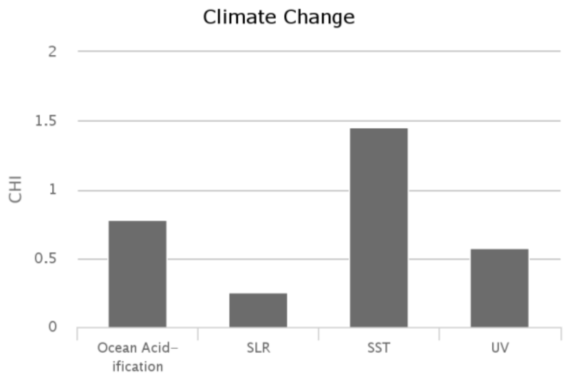


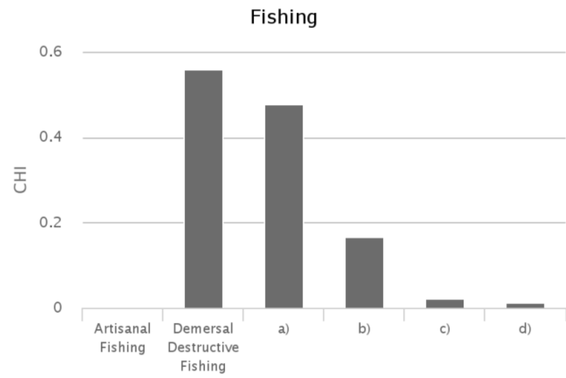
Marine Protected Area change

The East China Sea LME experienced an increase in MPA coverage from 2,022 km^2 prior to 1983 to 4,839 km^2 by 2014. This represents an increase of 139%, within the low category of MPA change.

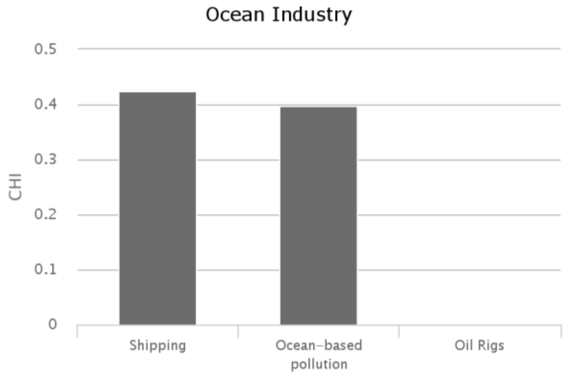
Cumulative Human Impact

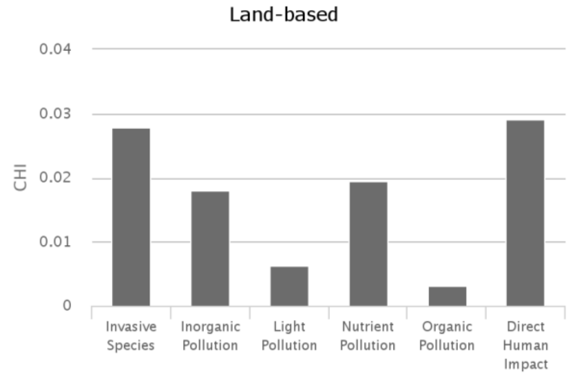
The East China Sea LME experiences the highest overall cumulative human impact of any LME (score 5.22). It falls in risk category 5 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, all four connected to climate change have the highest average impact on the LME: ocean acidification (0.78; maximum in other LMEs was 1.20), UV radiation (0.58; maximum in other LMEs was 0.76), sea level rise (0.25; maximum in other LMEs was 0.71), and sea surface temperature (1.46; maximum in other LMEs was 2.16). High average impact also came from demersal destructive fishing (0.56, the highest score for any LME), demersal non-destructive high-bycatch commercial fishing (0.48; maximum in other LMEs was 0.60), and commercial shipping (0.42; maximum in other LMEs was XX). Other key stressors include ocean based pollution, coastal human population pressure, pelagic high-bycatch commercial fisheries, invasive species, and demersal non-destructive low-bycatch commercial fishing.



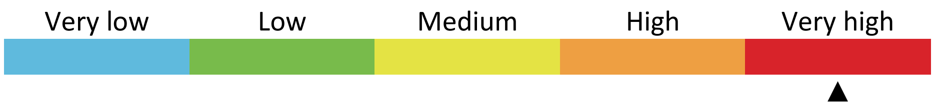


a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing



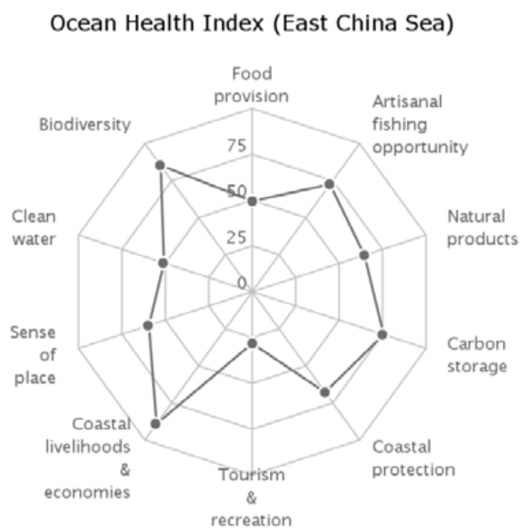


CHI: 5.22



Ocean Health Index

The East China Sea LME scores below average on the Ocean Health Index compared to other LMEs (score 66 out of 100; range for other LMEs was 57 to 82). This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 remained unchanged compared to the previous year. This LME scores lowest on fisheries, tourism & recreation, sense of place and clean waters goals and highest on coastal economies. It falls in risk category 5 of the five risk categories, which is the highest level of risk (1 = lowest risk; 5 = highest risk).



OHI: 64.23

Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 200 474 km^2. A current population of 136 598 thousand in 2010 is projected to increase to 166 221 thousand in 2100, with a density of 681 persons per km^2 in 2010 increasing to 829 per km^2 by 2100. About 30% of coastal population lives in rural areas, and is projected to maintain this share in 2100.

Total population		Rural population	
2010	**2100**	**2010**	**2100**
136,598,017	166,220,610	40,489,958	50,128,742

Legend: Very low · Low · Medium · High · Very high

Coastal poor

The indigent population makes up 8% of the LME's coastal dwellers. This LME places in the very low-risk category based on percentage and in the high-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
11,073,277

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the very high-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $6 955 million for the period 2001-2010. Fish protein accounts for 24% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$146 489 million places it in the very high-revenue category. On average, LME-based tourism income contributes 9% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with medium risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
6,954,896,024	24.3	146,489,000,000	9.1	0.7064

Legend: Very low, Low, Medium, High, Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the medium HDI and medium-risk category. Based on an HDI of 0.740, this LME has an HDI Gap of 0.260, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.
HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a very high-risk category (very low HDI) because of reduced income levels and increasing population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.7401	0.9065	0.5682

Legend: Very low, Low, Medium, High, Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.
The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (*e.g.* overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).
The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

Present day climate threat index of this LME is within the very high-risk (very high threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is very high. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and increases to very high under a fragmented world development pathway.

2010		2100	
Climate Threat	Contemporary Threat	SSP1	SSP3
0.8402	0.4799	0.3940	0.6530

Legend:

Very low, Low, Medium, High, Very high

Governance

Governance architecture

The two transboundary arrangements for fisheries in this LME - WCPFC and APFIC- cover high seas highly migratory tuna and tuna-like fisheries and the fisheries within national jurisdiction. There does not appear to be any formal connection between the two arrangements, possibly since they have different areas of competence. For pollution, NOWPAP potentially serves an integrating function but it does not appear to be linked to the fisheries arrangements, despite the impacts of pollution on the fisheries. Significantly, no formal arrangement for biodiversity was identified in this LME. It may be assumed that PEMSEA, with its concern for coastal management issues has addressed this issue but PEMSEA depends on voluntary action. No integrating mechanisms, such as an overall policy coordinating organisation for the LME, could be found. There may be interaction amongst the arrangements through participation in each other's meetings, but this appears to be informal.

The overall scores for ranking of risk were:

Engagement	Completeness	Integration
83	43	0.1

Legend:

Very low, Low, Medium, High, Very high

LME 48 – Yellow Sea

Bordering countries: China, Korea, Democratic Republic of Korea.
LME Total area: 438,619 km^2

List of indicators

LME overall risk

This LME falls in the cluster of LMEs that exhibit medium to high numbers of collapsed and overexploited fish stocks, high levels of demersal non-destructive low bycatch fishing, as well as very high shipping pressure.

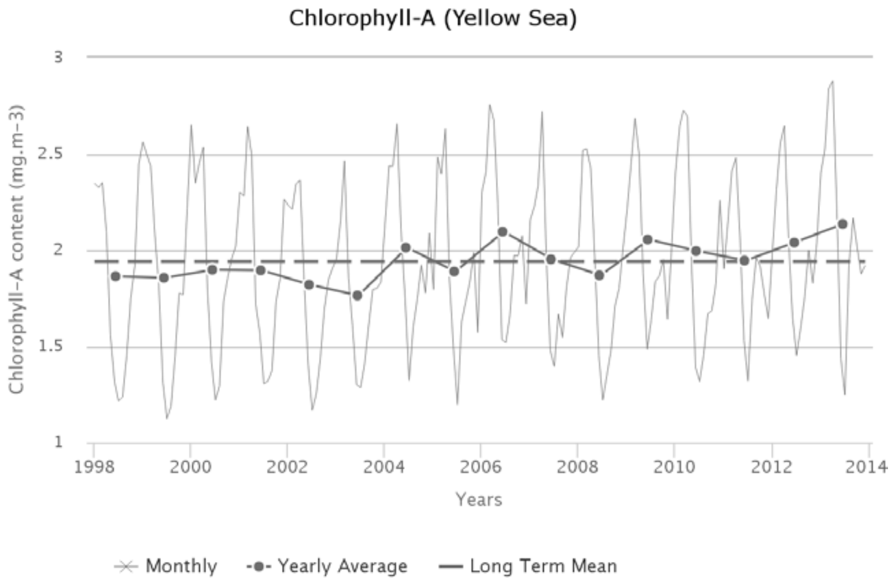
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very high.

Very low Low Medium High Very high

Productivity

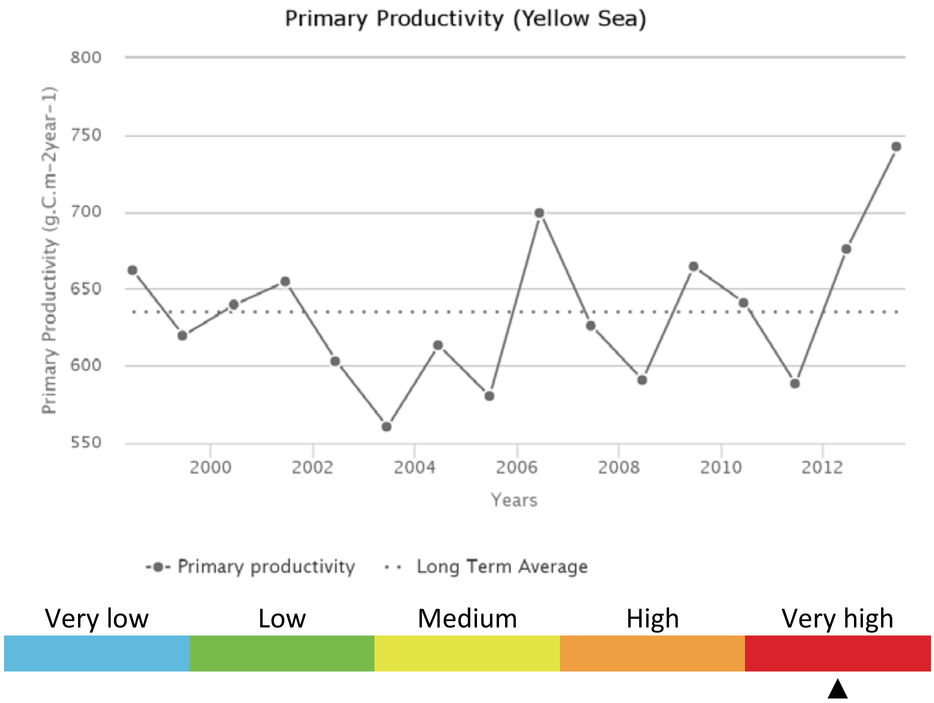
Chlorophyll-A

The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (2.55 mg.m^{-3}) in March and a minimum (1.36 mg.m^{-3}) during July. The average CHL is 1.94 mg.m^{-3}. Maximum primary productivity (742 g.C.m^{-2}.y^{-1}) occurred during 2013 and minimum primary productivity (560 g.C.m^{-2}.y^{-1}) during 2003. There is a statistically insignificant increasing trend in Chlorophyll of 13.9 % from 2003 through 2013. The average primary productivity is 635 g.C.m^{-2}.y^{-1}, which places this LME in Group 5 of 5 categories (with 1 = lowest and 5= highest).



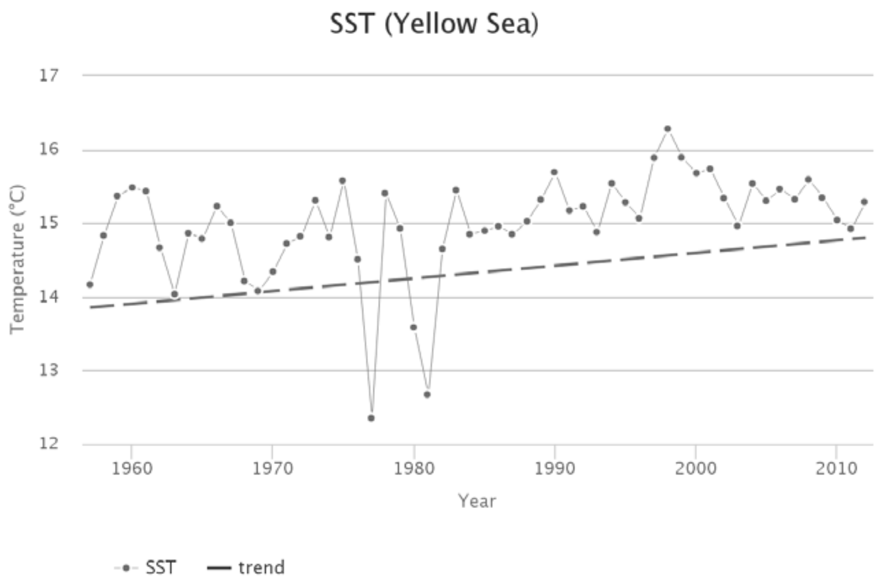
Very low Low Medium High Very high

Primary productivity



Sea Surface Temperature

From 1957 to 2012, the Yellow Sea LME #48 has warmed by 0.93°C, thus belonging to Category 2 (fast warming LME). This LME experienced steady long-term warming from 1957 to 2012 save for two extremely abrupt and strong cold spells in the 1970s (when SST dropped to 12.4°C in 1977) and a recent cooling after the all-time maximum of 16.2°C in 1998 (El Niño). The magnitude and duration of the recent cooling are noteworthy: 1.2°C in 14 years. In fact, after the 1998 peak, the SST dropped by 1.2°C in just 5 years. The magnitude of cold spells that peaked in 1977 and 1981 is unprecedented for the World Ocean. Since these data were obtained prior to the advent of reliable SST from satellites, these data must have been obtained in situ. Belkin and Lee (2014) reviewed SST data in this region and cast doubt on the validity of these extremely low temperatures in 1977 and 1981.

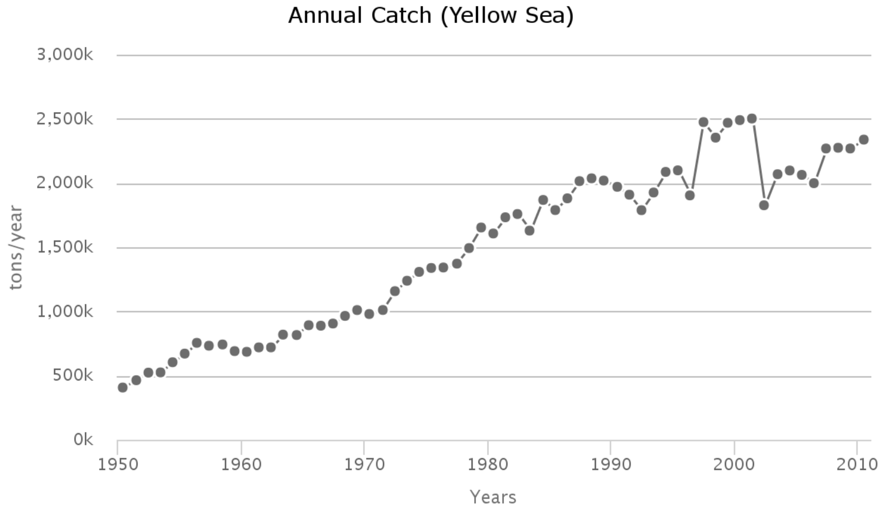


Fish and Fisheries

The Yellow Sea LME has well-developed multispecies and multinational fisheries. The fish communities are diverse, ranging from warm water species to cold temperate species. Among the many species of fish, squid and crustaceans that are commercially fished, Pacific saury (*Cololabis saira*), chub mackerel (*Scomber japonicus*), hairtail (*Trichiurus lepturus*), Japanese anchovy (*Engraulis japonicus*), yellow croaker (*Pseudosciaena polyactis*) and Japanese flying squid (*Todarodes pacificus*) are prominent.

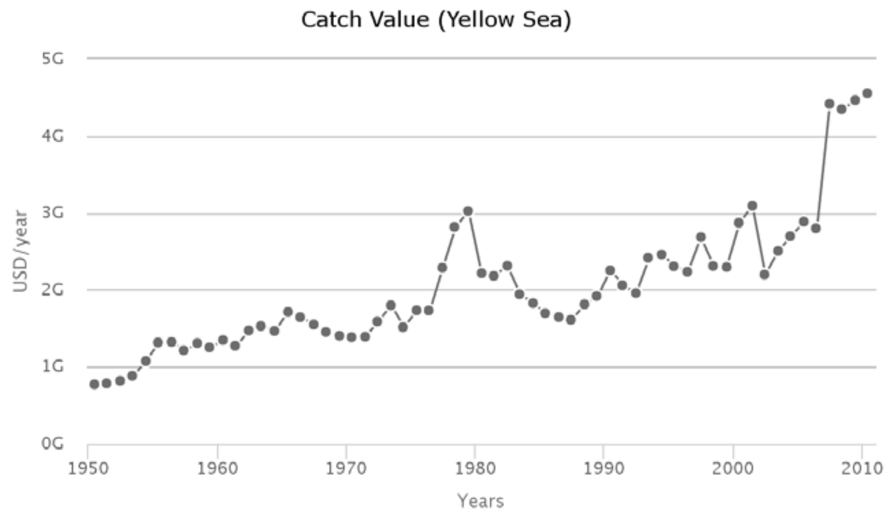
Annual Catch

Total reported landings in the LME have been on the rise, recording 2.5 million t in 2001 and 2.2 million t in recent decade.



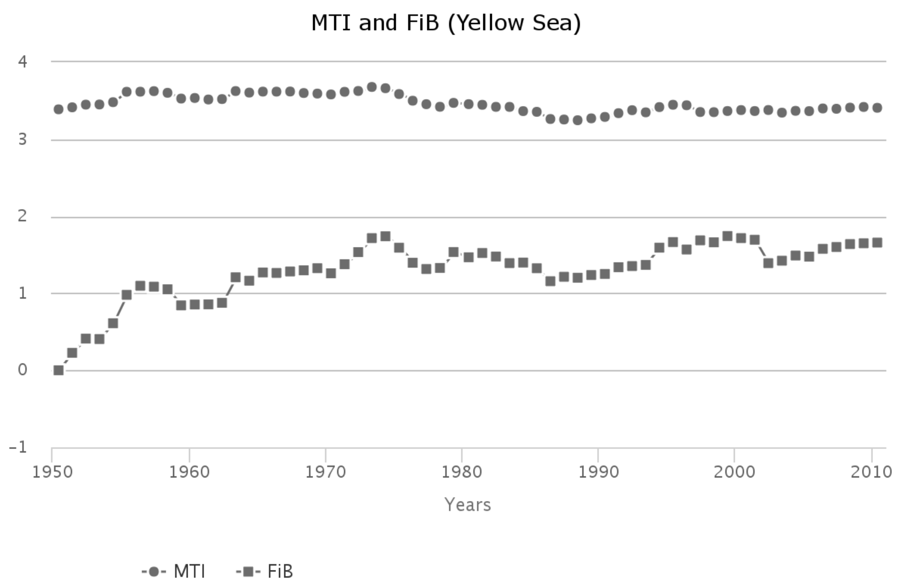
Catch value

The value of the reported landings peaked at 3.4 billion US$ (in 2005 real US$) in recent 10 years.



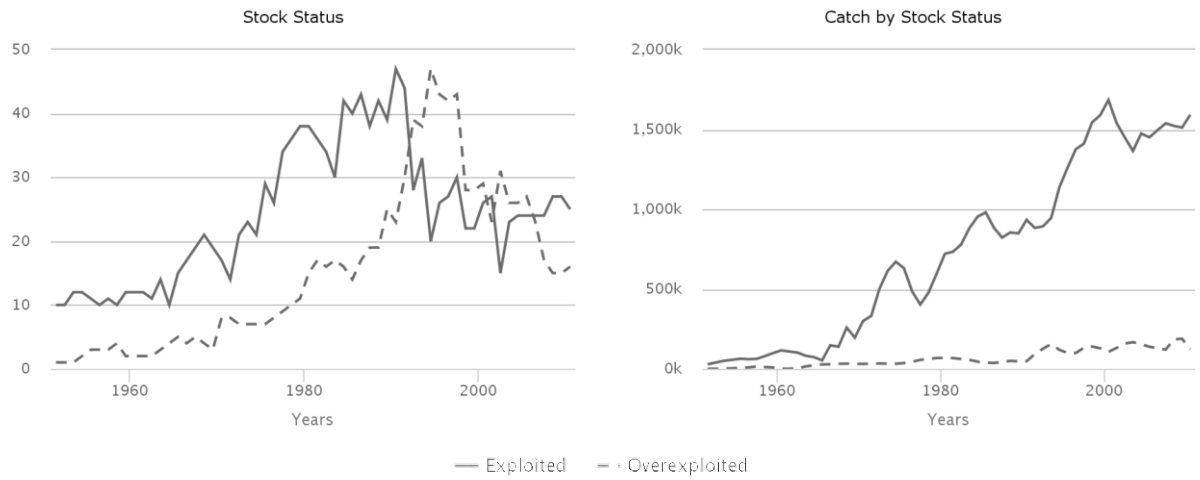
Marine Trophic Index and Fishing-in-Balance index

The MTI and the FiB index are difficult to interpret, likely due to the possible misreporting in the underlying catch statistics.



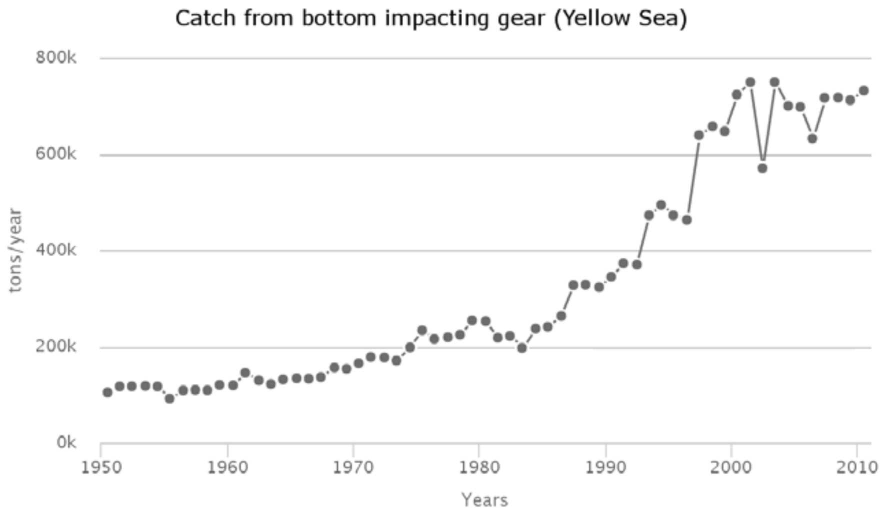
Stock status

The Stock-Catch Status Plots indicate that the number of the collapsed and overexploited stocks have been increasing, accounting for 35% of the commercially exploited stocks in the LME. However, 75% of the catch still supplied by fully exploited stocks. Again, the quality of the underlying catch data must be questioned.



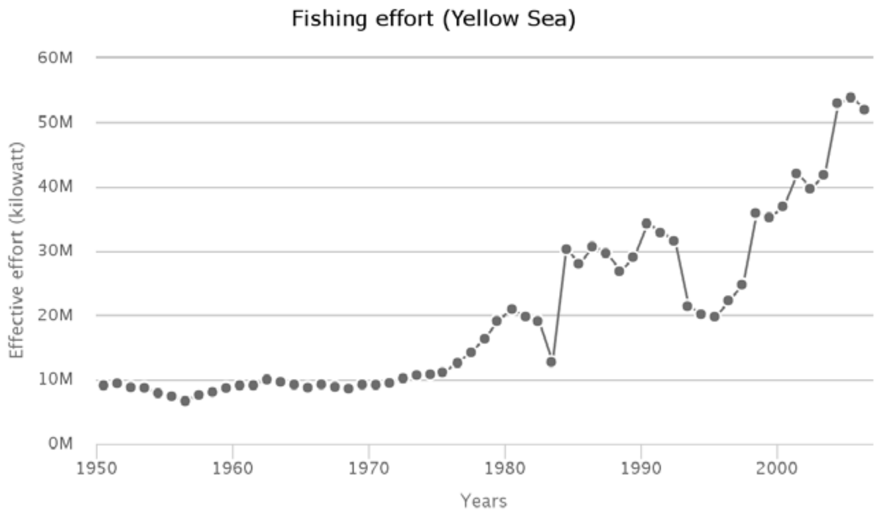
Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch fluctuated between 12 and 36% from 1950 to 2010. This percentage fluctuated around 32% in the recent decade.



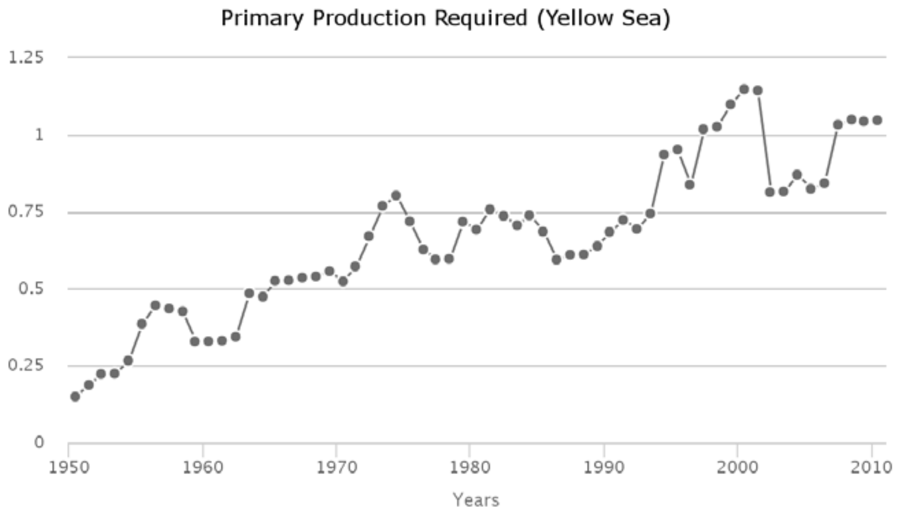
Fishing effort

The total effective effort continuously increased from around 9 million kW in the 1950s to its peak around 54 million kW in 2005.



Primary Production Required

The primary production required (PPR) to sustain the reported landings in this LME reached 90% of the observed primary production in the late 1990s, a level far too high to be realistic, and is likely due to misreporting of catches outside the LME as local catch.



Pollution and Ecosystem Health

Pollution

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An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was moderate (level 3 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a “current trends” scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was high (4). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was high (4). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
3	4	4	3	4	4	3	4	4

Legend:

Very low · Low · Medium · High · Very high

POPs

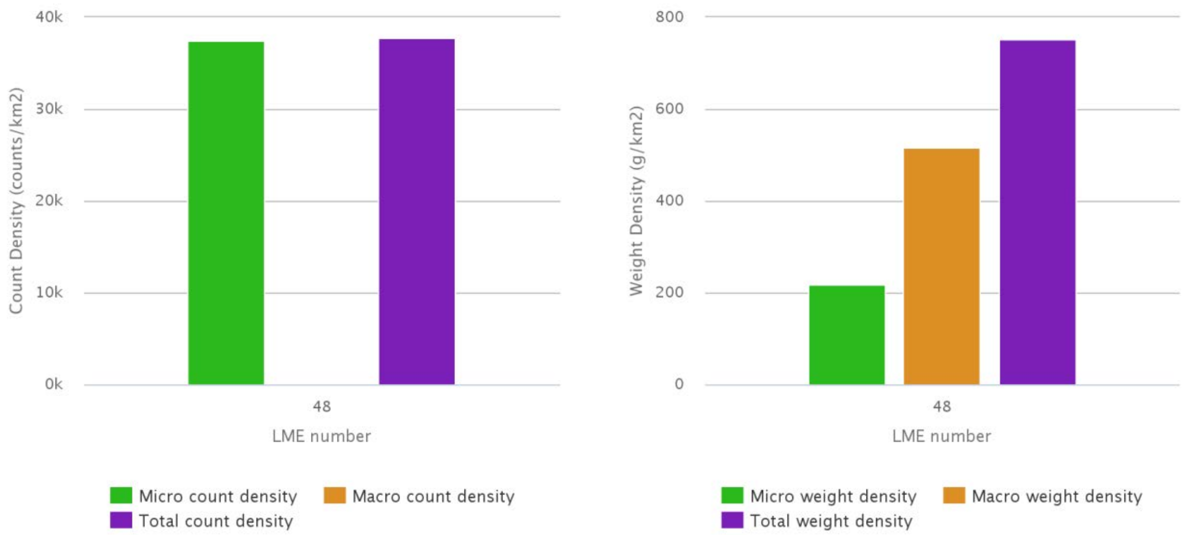
Data are available for only one sample at one location in Korea. This location shows minimal concentration of PCBs (2 ng.g-1 of pellets) and DDTs (1 $ng.g^{-1}$ of pellets), both in category 1 of the five risk categories (1=lowest risk; 5= highest risk). Because of economic growth in this LME, more locations should be monitored.

Locations	PCBs Avg. (ng/g)	PCBs Risk	DDTs Avg. (ng/g)	DDTs Risk	HCHs Avg. (ng/g)	HCHs Risk
1	2	**1**	1	**1**	n.d.	**n.d.**

Legend: Very low, Low, Medium, High, Very high

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with the highest plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The high values are due to relative importance of these sources in this LME. The abundance of floating plastic in this category is estimated to be on average over 400 times higher that those LMEs with lowest values. There is limited evidence from sea-based direct observations and towed nets to support this conclusion.



Ecosystem Health

Mangrove and coral cover

Not applicable.

Reefs at risk

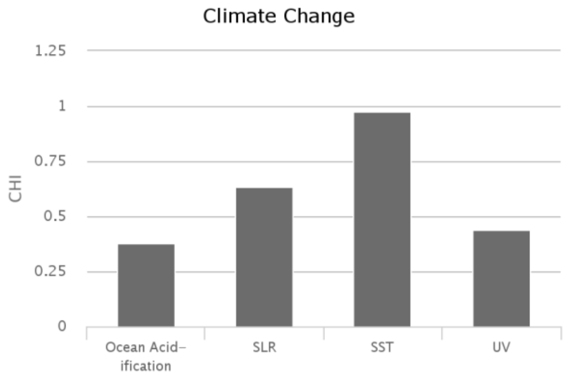
Not applicable.

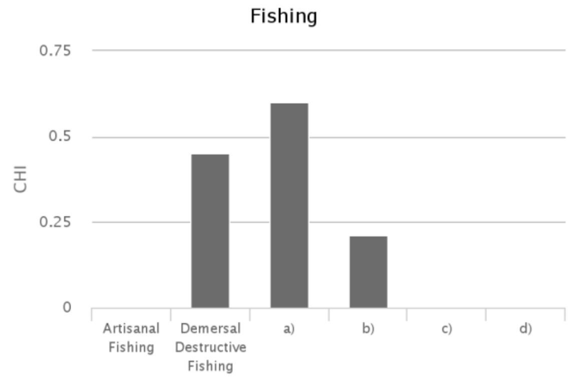
Marine Protected Area change

The Yellow Sea LME experienced an increase in MPA coverage from 1,514 km^2 prior to 1983 to 3,128 km^2 by 2014. This represents an increase of 109%, within the low category of MPA change.

Cumulative Human Impact

The Yellow Sea LME experiences well above average overall cumulative human impact (score 4.74; maximum LME score 5.22). It falls in risk category 5 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, all four connected to climate change have the highest average impact on the LME: ocean acidification (0.38; maximum in other LMEs was 1.20), UV radiation (0.44; maximum in other LMEs was 0.76), sea level rise (0.64; maximum in other LMEs was 0.71), and sea surface temperature (0.97; maximum in other LMEs was 2.16). All three types of demersal commercial fishing also had very high impact: destructive (0.45; maximum in other LMEs was 0.56), non-destructive low-bycatch (0.21; which is the maximum of any LME), and non-destructive high-bycatch (0.60; which is the maximum of any LME). Other key stressors include commercial shipping, nutrient pollution from land, direct pressure from coastal population, invasive species, and ocean based pollution.





a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
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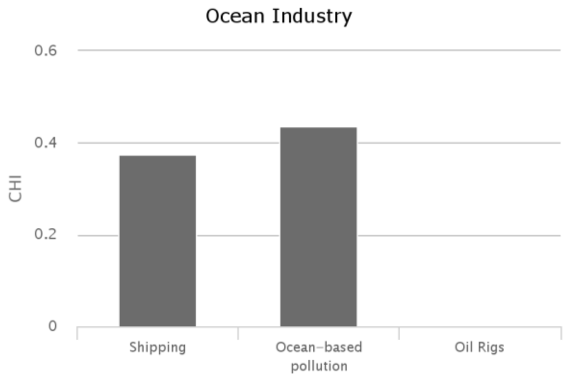
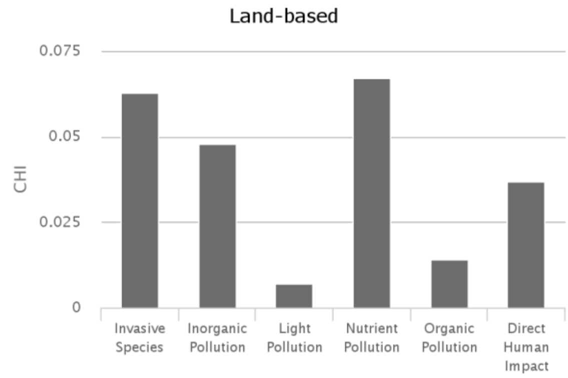
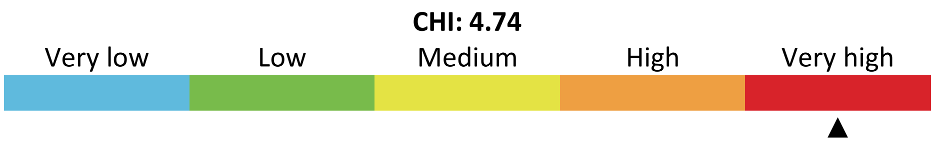
d) Pelagic Low Bycatch Fishing



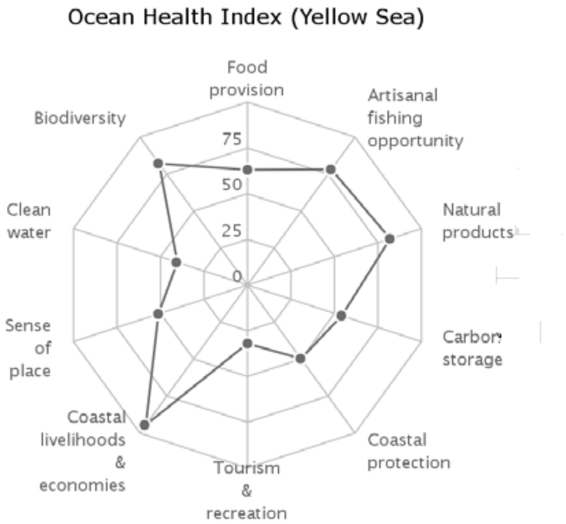




Ocean Health Index

The Yellow Sea LME scores below average on the Ocean Health Index compared to other LMEs (score 65 out of 100; range for other LMEs was 57 to 82). This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 increased 1 point compared to the previous year, due in large part to changes in the score for natural products. This LME scores lowest on fisheries, coastal protection, carbon storage, tourism & recreation, lasting special places, and clean waters goals and highest on coastal livelihoods &

economies. It falls in risk category 5 of the five risk categories, which is the highest level of risk (1 = lowest risk; 5 = highest risk).



OHI: 63.9

Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 324 634 km^2. A current population of 170 224 thousand in 2010 is projected to increase to 225 934 thousand in 2100, with a density of 524 persons per km^2 in 2010 increasing to 696 per km^2 by 2100. About 38% of coastal population lives in rural areas, and is projected to increase in share to 40% in 2100.

Total population		Rural population	
2010	**2100**	**2010**	**2100**
170,223,678	225,934,193	63,459,004	89,927,819

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 9% of the LME's coastal dwellers. This LME places in the very low-risk category based on percentage and in the very high-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
15,351,353

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the very high-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013

$4 042 million for the period 2001-2010. Fish protein accounts for 26% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013 $208 962 million places it in the very high-revenue category. On average, LME-based tourism income contributes 10% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with low risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
4,041,976,555	25.8	208,962,000,000	9.8	0.6838

Legend: Very low, Low, Medium, High, Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the medium HDI and medium-risk category. Based on an HDI of 0.752, this LME has an HDI Gap of 0.248, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.
HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a very high-risk category (very low HDI) because of reduced income levels and increasing population values from those in a sustainable development pathway..

	HDI 2100	
HDI	SSP1	SSP3
0.7516	0.9108	0.5823

Legend: Very low, Low, Medium, High, Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.
The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (e.g. overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).
The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in

the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

Present day climate threat index of this LME is within the very high-risk (very high threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is very high. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and increases to high under a fragmented world development pathway.

2010		2100	
Climate Threat	Contemporary Threat	SSP1	SSP3
0.8296	0.4744	0.3807	0.6339

Legend: Very low, Low, Medium, High, Very high

Governance

Governance architecture

The appearance of high integration among transboundary arrangements in this LME arises because they are all under NOWPAP. However, it must be recalled that NOWPAP is purely a coordination mechanism that has no international legal standing. Therefore, the apparent degree of integration that may arise from sharing a common organisation is essentially informal. No integrating mechanisms, such as an overall policy coordinating organisation for the LME, could be found. The Yellow Sea Partnership established by the YSLME Project and intended as a precursor to the YSLME Commission is an arrangement that has the potential to become an integrating agency.

The overall scores for ranking of risk were:

Engagement	Completeness	Integration
67	33	0.5

Legend: Very low, Low, Medium, High, Very high

LME 49 – Kuroshio Current

Bordering countries: Japan, Philippines, Taiwan.
LME Total area: 1,333,074 km^2

List of indicators

LME overall risk

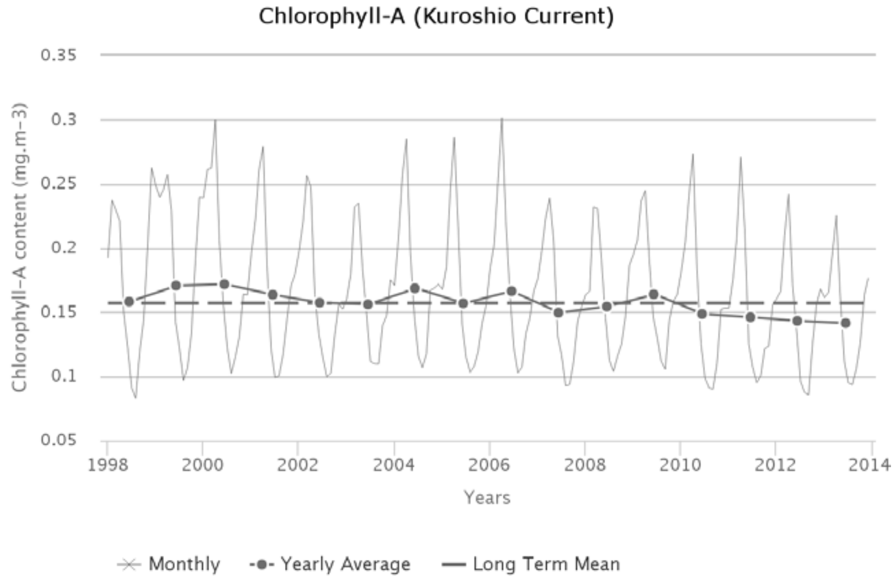
This LME falls in the cluster of LMEs that exhibit medium to high numbers of collapsed and overexploited fish stocks, high levels of demersal non-destructive low bycatch fishing, as well as very high shipping pressure.

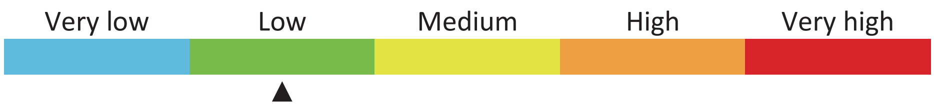
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is medium.

Productivity

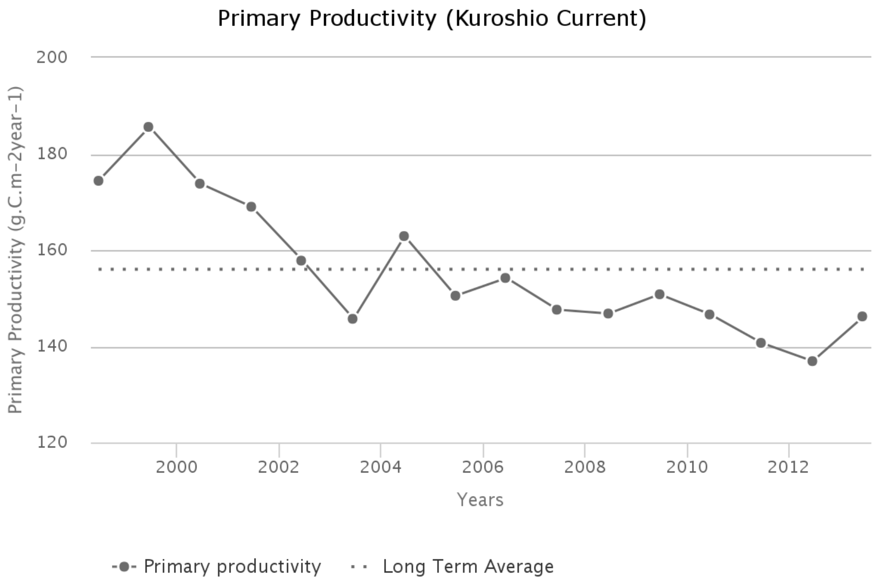
Chlorophyll-A

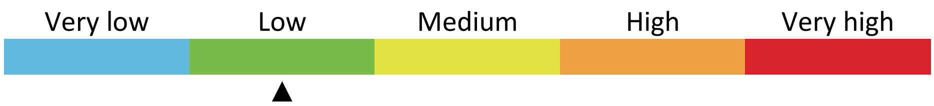
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.253 mg.m^{-3}) in April and a minimum (0.0989 mg.m^{-3}) during August. The average CHL is 0.157 mg.m^{-3}. Maximum primary productivity (186 g.C.m^{-2}.y^{-1}) occurred during 1999 and minimum primary productivity (137 g.C.m^{-2}.y^{-1}) during 2012. There is a statistically insignificant decreasing trend in Chlorophyll of -8.96 % from 2003 through 2013. The average primary productivity is 156 g.C.m^{-2}.y^{-1}, which places this LME in Group 2 of 5 categories (with 1 = lowest and 5= highest).





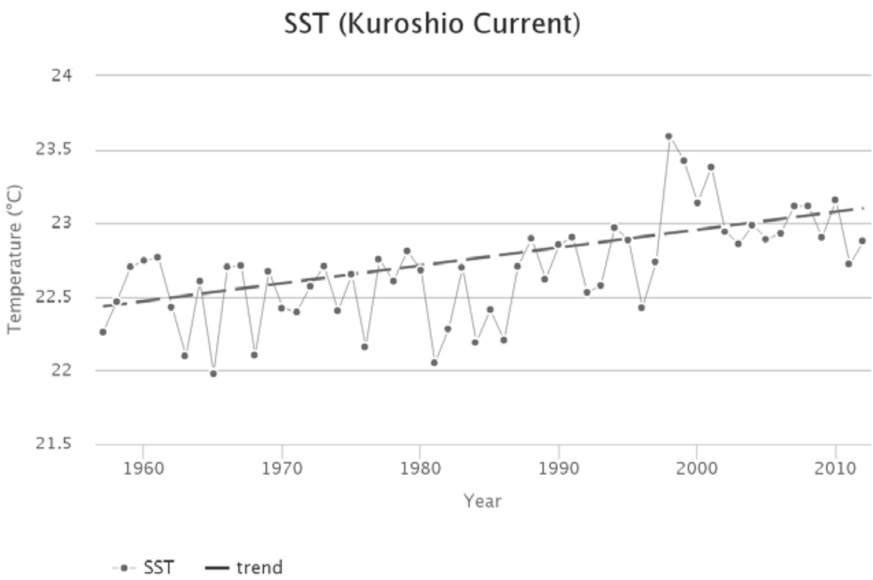
Primary productivity





Sea Surface Temperature

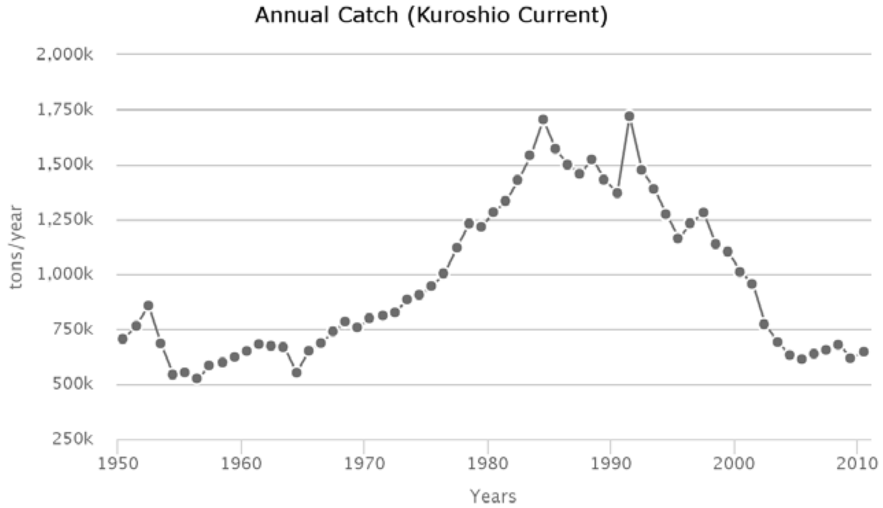
From 1957 to 2012, the Kuroshio Current LME #49 has warmed by 0.70°C, thus belonging to Category 3 (moderate warming LME). The thermal history of this LME is similar to that of the East China Sea. Both saw a relatively stable epoch in the 1960s-1970s, and a rapid warming in the 1980s-1990s culminated (and terminated) by the 1998 El-Niño. The main difference is that in the Kuroshio Current the stable epoch lasted longer, through 1986. The rather sharp decline of SST after the 1998 El Niño was also quite similar in the Kuroshio and East China Sea, and also in the Taiwan Strait (Belkin, 2009; Belkin and Lee, 2014). The thermal regime of the Kuroshio LME exerts a profound impact on (1) the Taiwan Strait via the Luzon Strait and South China Sea, and (2) the East China Sea via the Kuroshio incursions onto the outer East China Sea shelf (Belkin and Lee, 2014).



Fish and Fisheries

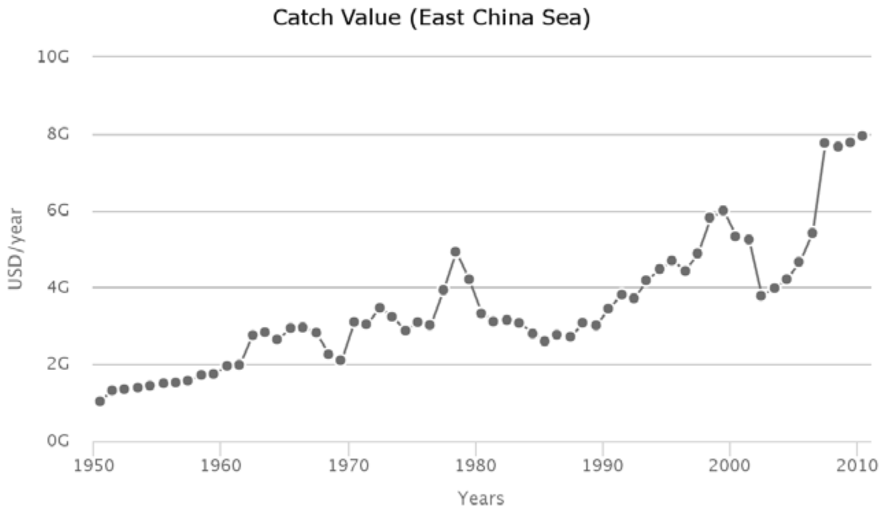
Annual Catch

Total reported landings in this LME reached 1.5 million t in late 1980s, but has been on a decline following the collapse of the sardine fisheries which dominated the landings in the 1980s.



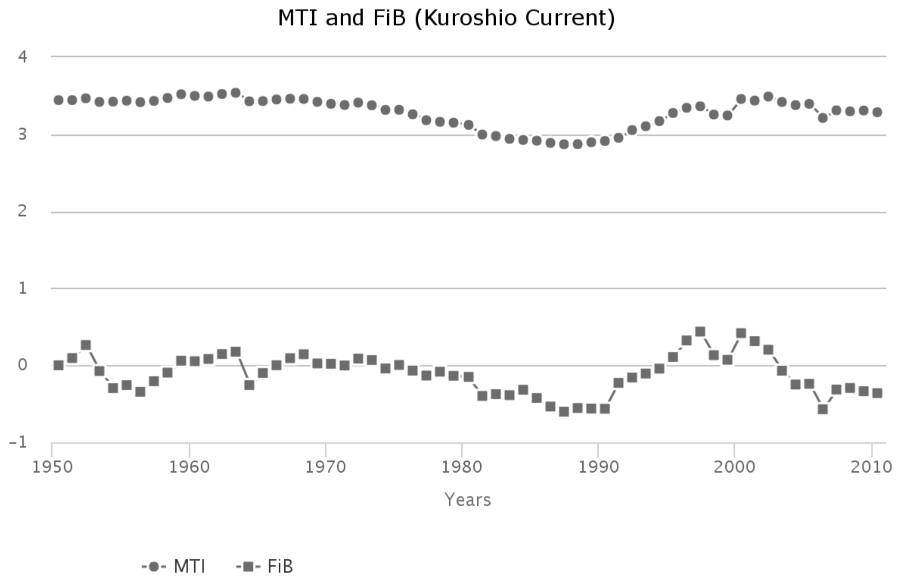
Catch value

The value of the reported landing recorded a peak of nearly 3 billion US$ (in 2005 real US$) in 1995 but has declined along with the reduced landings.



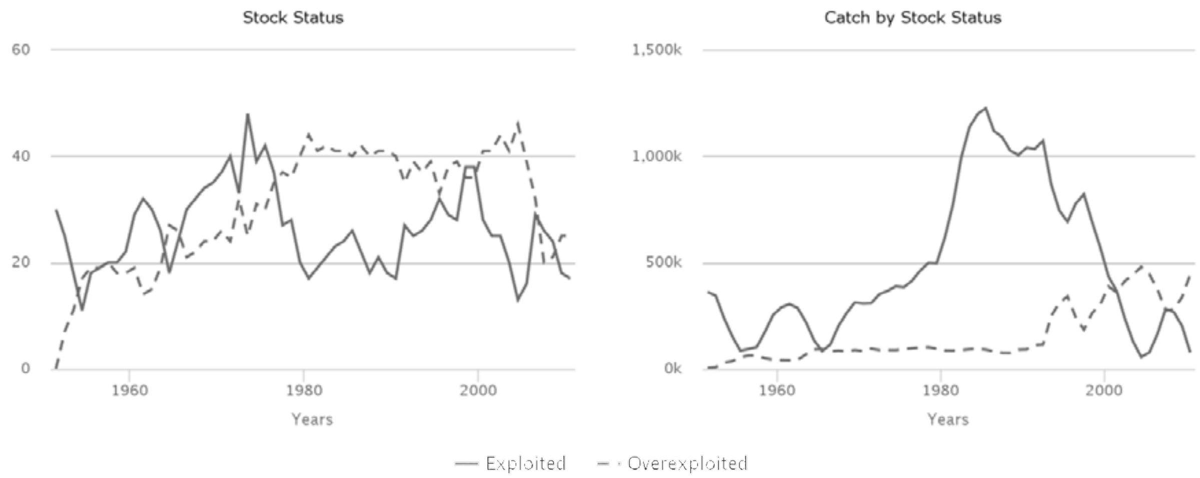
Marine Trophic Index and Fishing-in-Balance index

The MTI shows a series of large fluctuations, reflecting the cyclic nature in the relative abundance, and hence the landings of Pacific sardine in the LME. The FiB index declined from mid 1960s to 1980s, indicating that a "fishing down" of the food webs in the LME. After late 1980s, the FiB index continued to increase until late 1990s, indicating the geographical expansion of the fisheries.



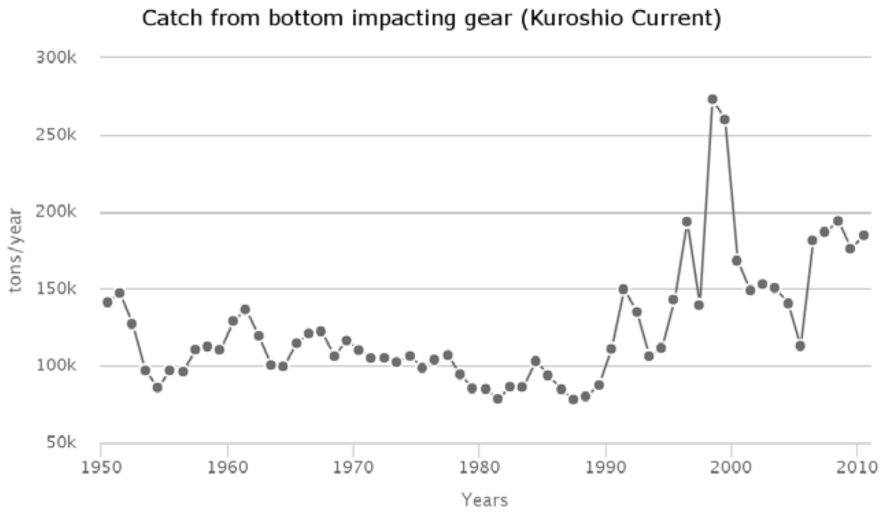
Stock status

The Stock-Catch Status Plots indicate that the number of collapsed and overexploited stock has been on a rise, accounting for 55% of the commercially exploited stocks by 2010, with more than half of the reported landings supplied by overexploited stocks. This is in line with the landings trends, which are declining since the mid-1980s.



Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch decreased from around 18% in the 1950s to its lowest point at around 5% in 1987. Then, this percentage kept increasing and fluctuated around 28% in recent decade.

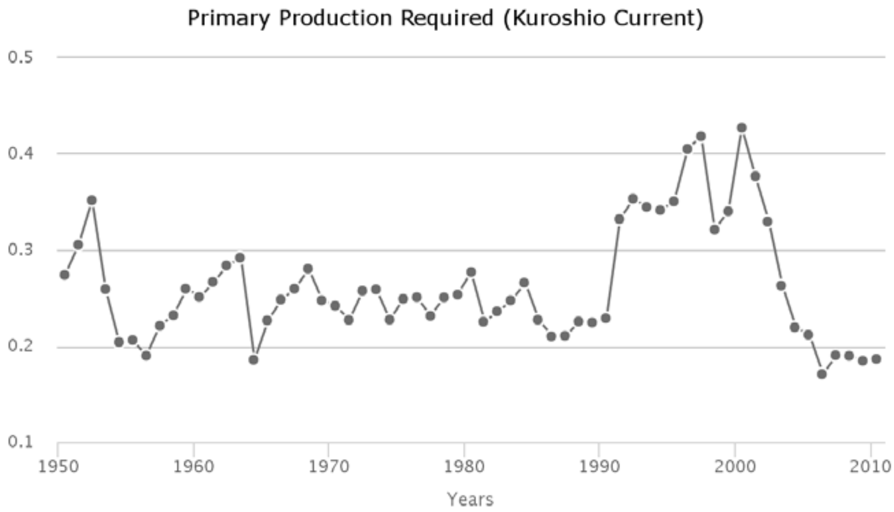


Fishing effort

The total effective effort continuously increased from around 36 million kW in the 1950s to its peak around 215 million kW in 2005.

Primary Production Required

The primary production required (PPR) to sustain the reported landings in the LME reached 70% of the observed primary production in the late 1990s. Two likely explanations for the extremely high level of PPR recorded in the 1980s and 1990s are the over-reporting in the underlying landings statistics by China and the shift in the distribution of Pacific sardine beyond the LME boundary which may have resulted in misreporting of some of sardine landings as being caught within the LME.



Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans.

An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was moderate (level 3 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was low (2). According to the Global Orchestration scenario, this remained the same in 2030 and decreased to very low in 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was moderate (3). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
3	2	3	3	2	3	3	1	3

Legend:

Very low · Low · Medium · High · Very high

POPs

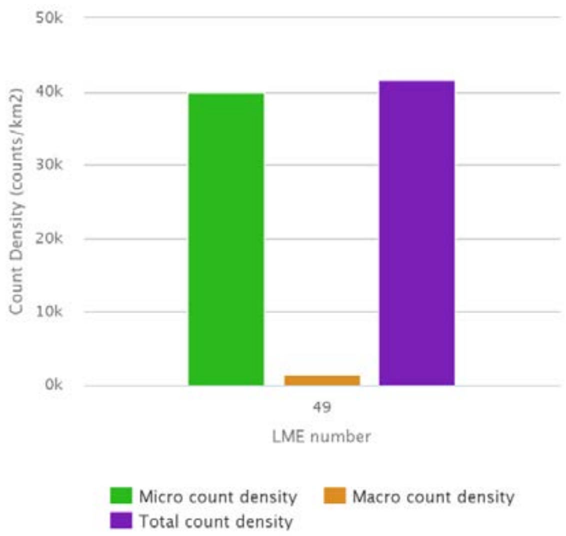
Data are available from 6 samples from 4 locations in Tokyo Bay. All the samples show high to extremely high PCBs concentrations (average 474, range 259-653 $ng.g^{-1}$ of pellets), moderate concentrations for DDTs (average 50, range 21-79 $ng.g^{-1}$), and minimal concentrations (1.6, range 1.2-2.1 $ng.g^{-1}$) for HCHs. PCBs and DDTs averages correspond to risk categories 4 and 3, respectively, of the five risk categories (1 = lowest risk; 5 = highest risk). Both PCBs and DDTs are derived from legacy pollution source in the bottom sediment. PCB concentration was more than 500 $ng.g^{-1}$, corresponding to risk category 5, even in the recent samples collected from the inner head of the bay. Some remediation action (e.g., dredging, capping) is necessary if the consumption of seafood from the area is allowed. Comprehensive monitoring including in some other coasts in this LME is highly recommended to ensure that the pollution status was not overestimated.

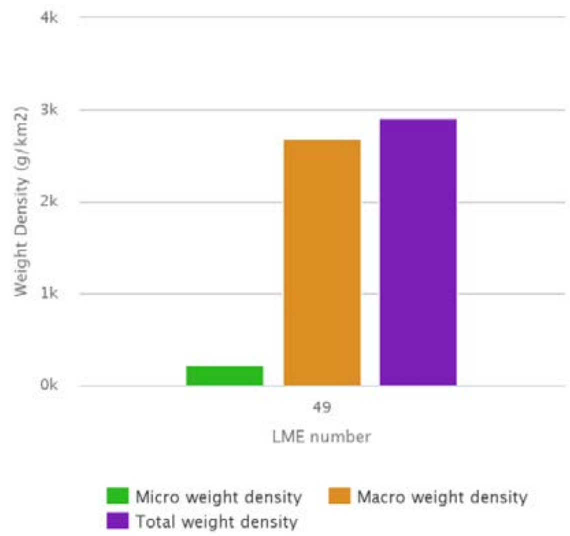
	PCBs		DDTs		HCHs	
Locations	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk
6	474	**4**	50	**3**	1.6	**1**

Legend: Very low; Low; Medium; High; Very high

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with the highest plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The high values are due to relative importance of these sources in this LME. The abundance of floating plastic in this category is estimated to be on average over 400 times higher that those LMEs with lowest values. There is limited evidence from sea-based direct observations and towed nets to support this conclusion.





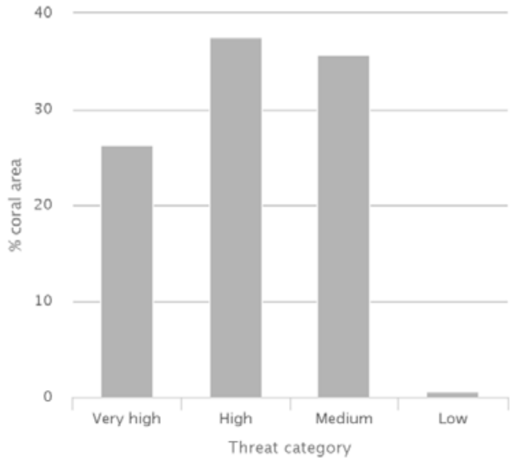
Ecosystem Health

Mangrove and coral cover

0.0008% of this LME is covered by mangroves (US Geological Survey, 2011) and 0.12% by coral reefs (Global Distribution of Coral Reefs, 2010).

Reefs at risk

This LME has a present (2011) integrated threat index (combining threat from overfishing and destructive fishing, watershed-based and marine-based pollution and damage) of 289. 26% of coral reefs cover is under very high threat, and 37% under high threat (of the 5 possible threat categories, from low to critical). When combined with past thermal stress (between 1998 and 2007), these values increase to 59% and 30% for very high and high threat categories respectively. By year 2030, 42% of coral cover in this LME is predicted to be under very high to critical level of threat from warming and acidification; this proportion increases to 64% by 2050.

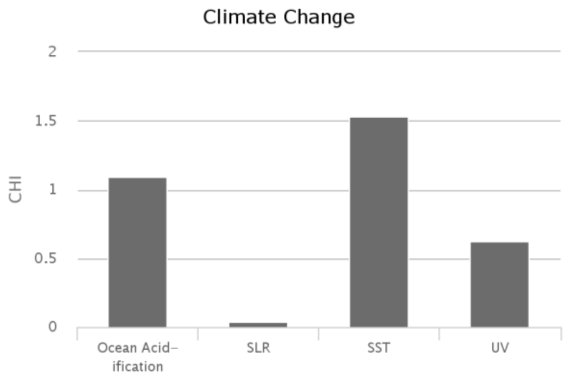


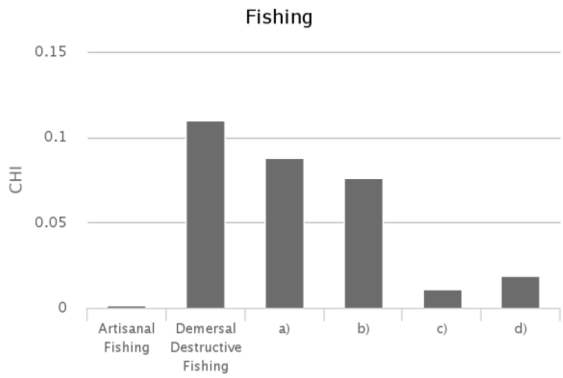
Marine Protected Area change

The Kuroshio Current LME experienced an increase in MPA coverage from 2,339 km^2 prior to 1983 to 14,719 km^2 by 2014. This represents an increase of 529%, within the low category of MPA change.

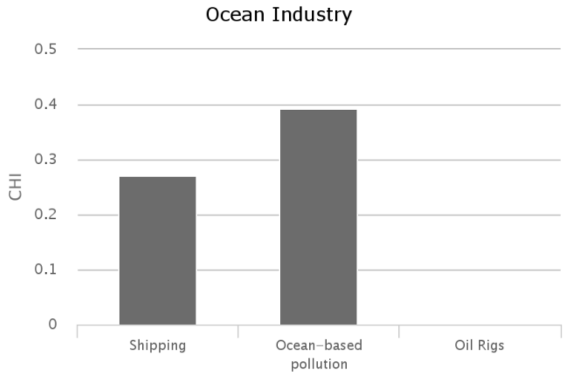
Cumulative Human Impact

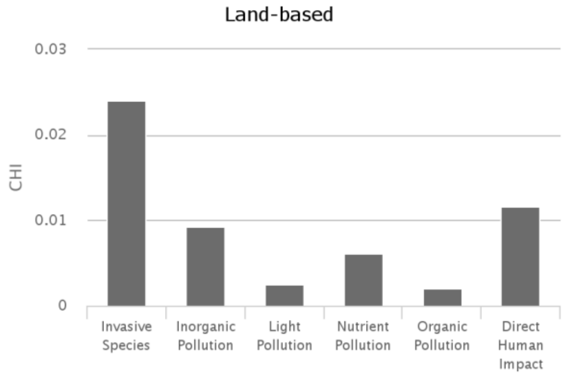
The Kuroshio Current LME experiences well above average overall cumulative human impact (score 4.32; maximum LME score 5.22). It falls in risk category 5 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (1.10; maximum in other LMEs was 1.20), UV radiation (0.63; maximum in other LMEs was 0.76), and sea surface temperature (1.53; maximum in other LMEs was 2.16). Other key stressors include commercial shipping, ocean based pollution, invasive species, and all three types of demersal commercial fishing (demersal destructive, non-destructive low-bycatch, and non-destructive high-bycatch).





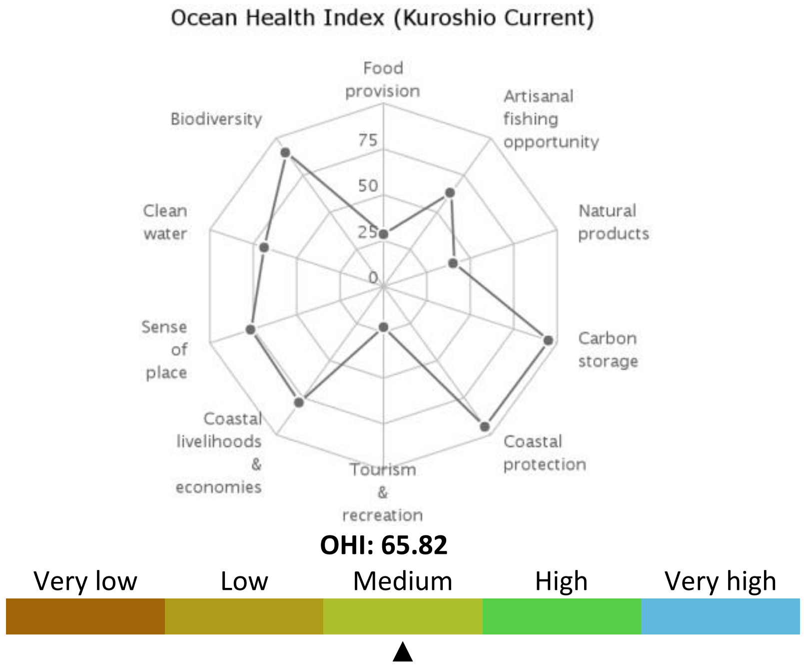
a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing





Ocean Health Index

The Kuroshio Current LME scores below average on the Ocean Health Index compared to other LMEs (score 69 out of 100; range for other LMEs was 57 to 82). This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 remained unchanged compared to the previous year. This LME scores lowest on food provision, natural products, tourism & recreation, and iconic species goals and highest on artisanal fishing opportunities, coastal protection, carbon storage, coastal economies, lasting special places, and habitat biodiversity goals. It falls in risk category 3 of the five risk categories, which is an average level of risk (1 = lowest risk; 5 = highest risk).



Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 260,980 km^2. A current population of 111 318 thousand in 2010 is projected to decrease to 91 035 thousand in 2100, with a density of 426 persons per km^2 in 2010 decreasing to 349 per km^2 by 2100. About 17% of coastal population lives in rural areas, and is projected to decrease in share to 16% in 2100.

Total population		Rural population	
2010	2100	2010	2100
111,318,152	91,035,098	19,299,434	14,175,411

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 15% of the LME's coastal dwellers. This LME places in the medium-risk category based on percentage and in the very high-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
17,036,565

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the high-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $1 617 million for the period 2001-2010. Fish protein accounts for 36% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$102 053 million places it in the very high-revenue category. On average, LME-based tourism income contributes 7% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with low risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
1,617,466,382	36.4	102,053,000,000	6.6	0.6610

Legend: Very low, Low, Medium, High, Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the very high HDI and very low-risk category. Based on an HDI of 0.887, this LME has an HDI Gap of 0.113, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a medium-risk category (medium HDI) because of reduced income levels and population values from those in a sustainable development pathway.

HDI	HDI 2100	
	SSP1	SSP3
0.8865	0.9807	0.7541

Legend: Very low, Low, Medium, High, Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (e.g. overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

Present day climate threat index of this LME is within the low-risk (low threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is medium. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and increases to medium under a fragmented world development pathway.

2010		2100	
Climate Threat	**Contemporary Threat**	**SSP1**	**SSP3**
0.5115	0.3376	0.2334	0.5330

Legend:

Very low | Low | Medium | High | Very high

Governance

Governance architecture

In this LME, there is essentially no transboundary fisheries arrangement. However, PICES does provide opportunity for transboundary cooperation in assessment in science. The fact that there is no Regional Seas convention covering the area in this LME, but only an action plan (NOWPAP), seriously weakens capacity for transboundary governance in areas relating to pollution. Further, there is no indication of transboundary integration, other than through cooperation in science. There is the potential for integration of pollution issues under NOWPAP should it proceed to the level of a Convention. There does not appear to be any other transboundary organisation than NOWPAP that could integrate and coordinate across the full range of issues required for EBM.

The overall scores for ranking of risk were:

Engagement	Completeness	Integration
50	**56**	**0.3**

Legend:

Very low | Low | Medium | High | Very high

LME 50 – Sea of Japan

Bordering countries: Japan, Korea, Democratic Republic of Korea.
LME Total area: 1,054,305 km^2

List of indicators

LME overall risk

This LME falls in the cluster of LMEs that exhibit low to medium levels of economic development (based on the night light development index) and medium levels of collapsed and overexploited fish stocks.

Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is medium.

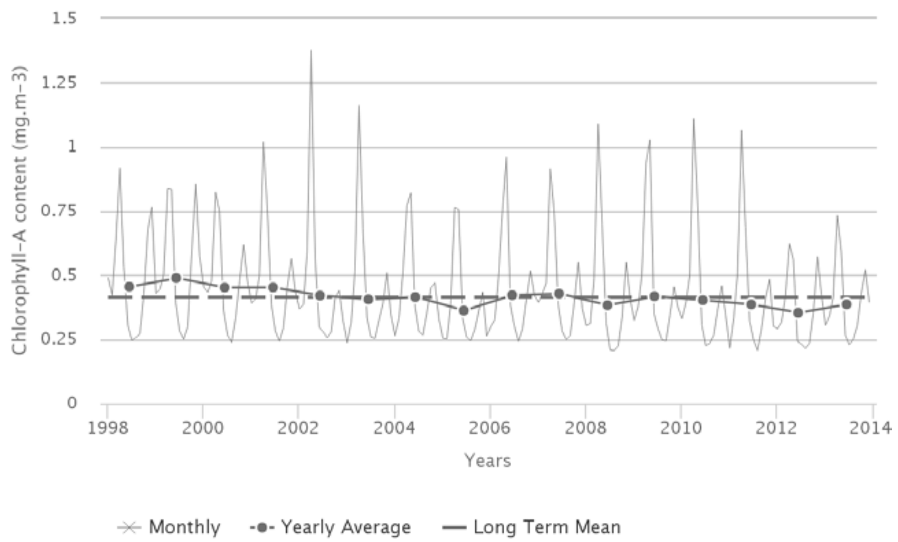
Very low | Low | Medium | High | Very high

Productivity

Chlorophyll-A

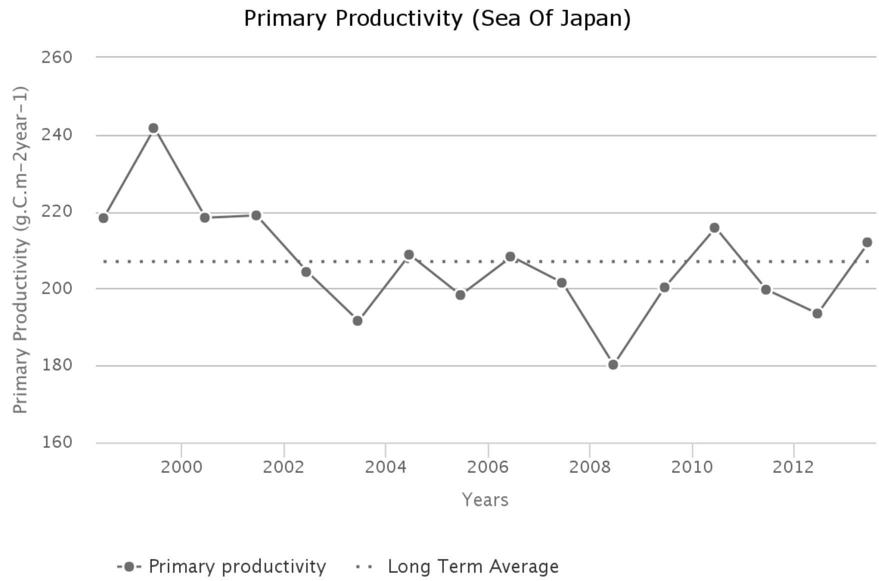
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.905 mg.m-3) in April and a minimum (0.242 mg.m-3) during August. The average CHL is 0.414 mg.m-3. Maximum primary productivity (242 g.C.m-2.y-1) occurred during 1999 and minimum primary productivity (180 g.C.m-2.y-1) during 2008. There is a statistically insignificant increasing trend in Chlorophyll of 6.79 % from 2003 through 2013. The average primary productivity is 207 g.C.m-2.y-1, which places this LME in Group 3 of 5 categories (with 1 = lowest and 5= highest).

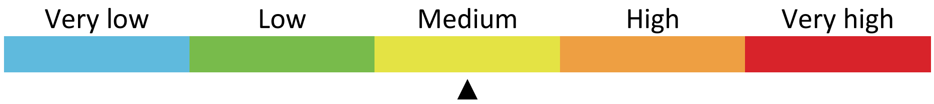
Chlorophyll-A (Sea Of Japan)



Very low | Low | Medium | High | Very high

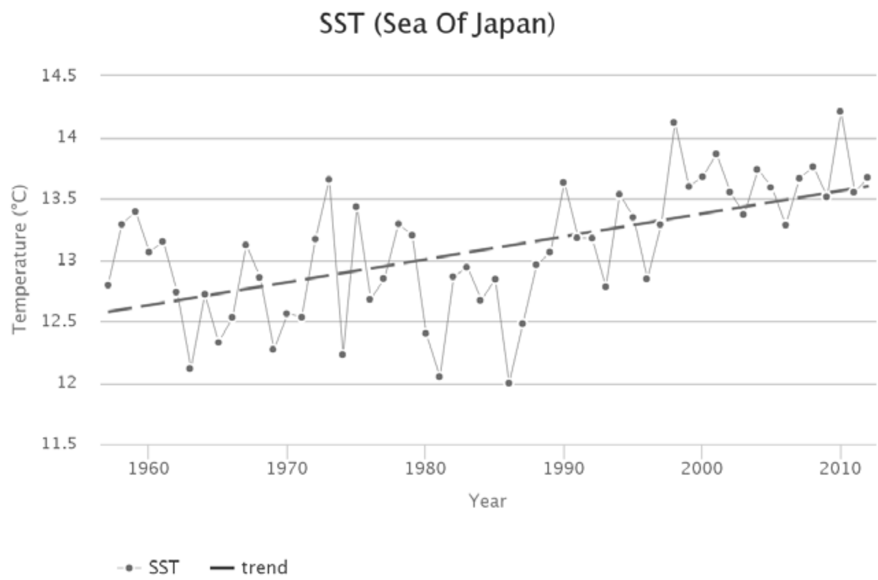
Primary productivity





Sea Surface Temperature

From 1957 to 2012, the Sea of Japan LME #50 has warmed by 1.05°C, thus belonging to Category 2 (fast warming LME). The Japan Sea–like the adjacent East China Sea–was not warming until the 1980s. Unlike the East China Sea, where abrupt warming began in 1982, the warming epoch in the Japan Sea commenced after 1986. Between 1986 and 2010, SST rose from 12.0°C to 14.1°C, an increase by 2.1°C in 23 years. The decadal variability of the Japan Sea is primarily influenced by the Siberian high, which is related to the Arctic Oscillation and North Atlantic Oscillation, and secondarily by the Aleutian low, whose decadal variability is linked to the Pacific Decadal Oscillation (Minobe et al., 2004). However, the North Pacific regime shift of 1976-1977 has not transpired in the Japan Sea SST time series.

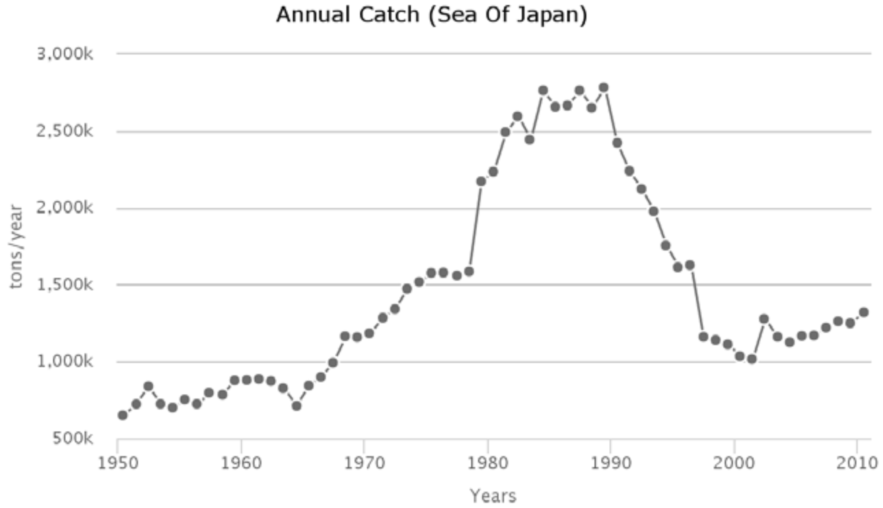


Fish and Fisheries

Marine fisheries are an important economic sector for the countries bordering the Sea of Japan LME. Both cold and warm-water fish occur in the LME, with salmon, Alaska pollock, sea urchin, sea cucumber, crab and shrimp being the most valuable species. Long-term fluctuations of Pacific sardine accompanied by noticeable geographic shifts in its spawning and nursery grounds have been observed, but no relationship has been found between high sardine catches and the Tsushima Current.

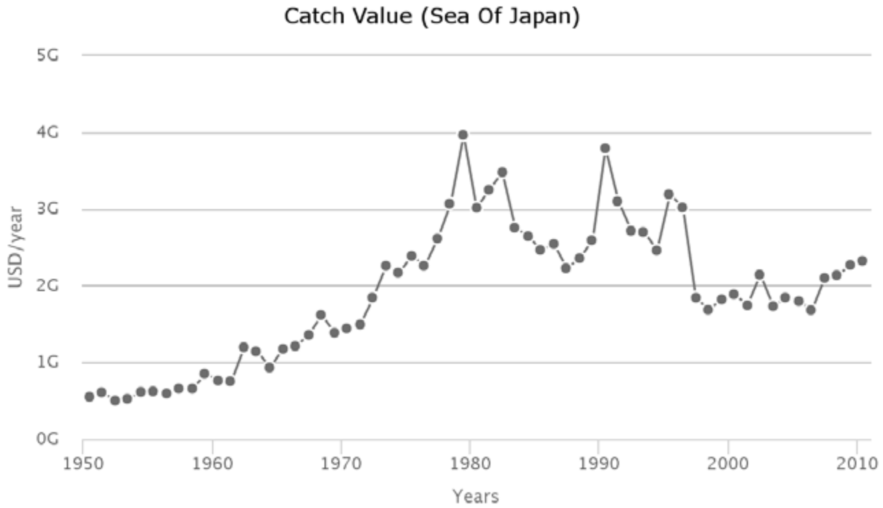
Annual Catch

Total reported landings in the LME reached 2.8 million t in 1989 but have since declined to around 1.2 million t in the recent 10 years. The fluctuation in the landings can be attributed mainly to the high reported landings of Pacific sardine, which accounted for 30% of the total landings in the mid to late 1980s.



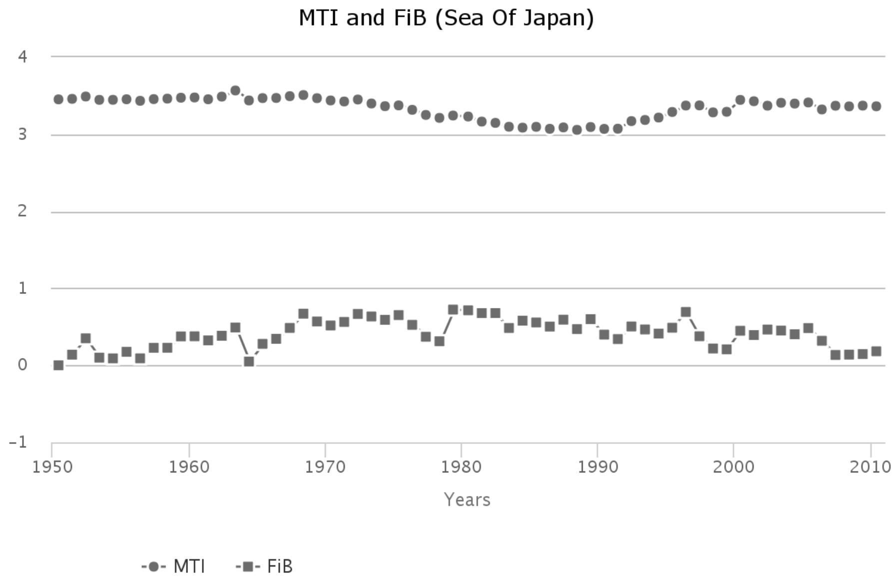
Catch value

The value of the reported landings also rose steadily to about 4 billion US$ (in 2005 real US$) in 1979.



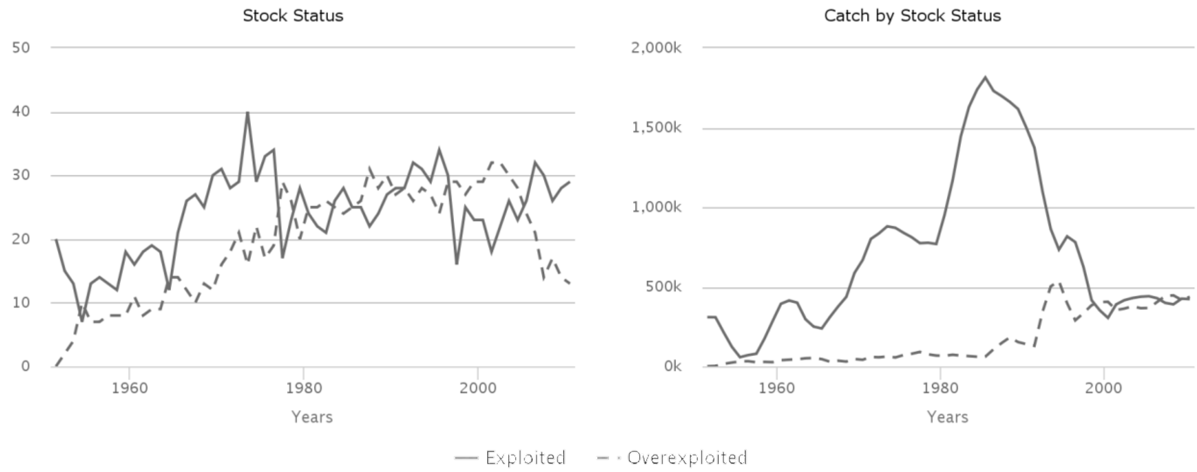
Marine Trophic Index and Fishing-in-Balance index

The MTI shows a large fluctuation, reflecting the cyclic nature in the relative abundance, and hence the landings, of the low-trophic Pacific sardine. The FiB index suggests a period of expansion in the 1950s and 1960s, after which the index levels off, indicating that the decrease in the mean trophic level resulting from the high proportion of reported landings of Pacific sardine in the 1980s was compensated for by its large volume of landings.



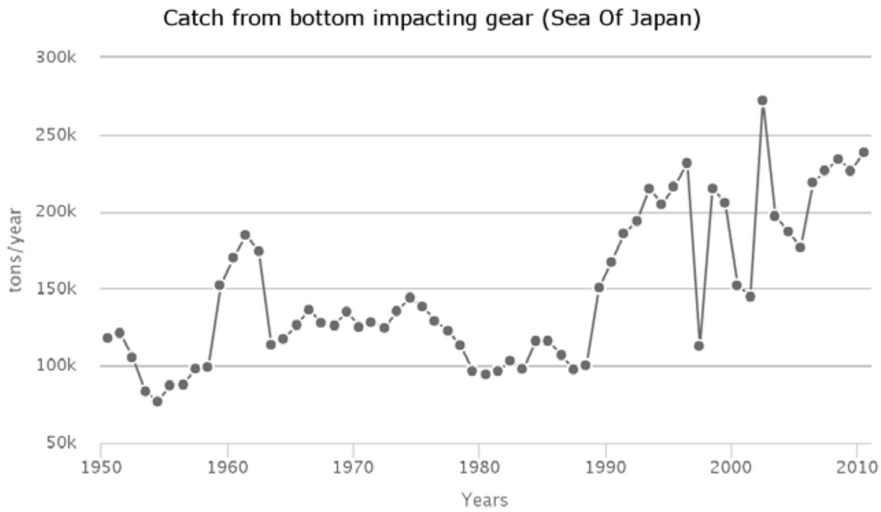
Stock status

The Stock-Catch Status Plots indicate that the number of collapsed and overexploited stocks in the LME has been rapidly increasing, to 30 % of the commercially exploited stocks, with about 40% of the reported landings still supplied by fully exploited stocks.



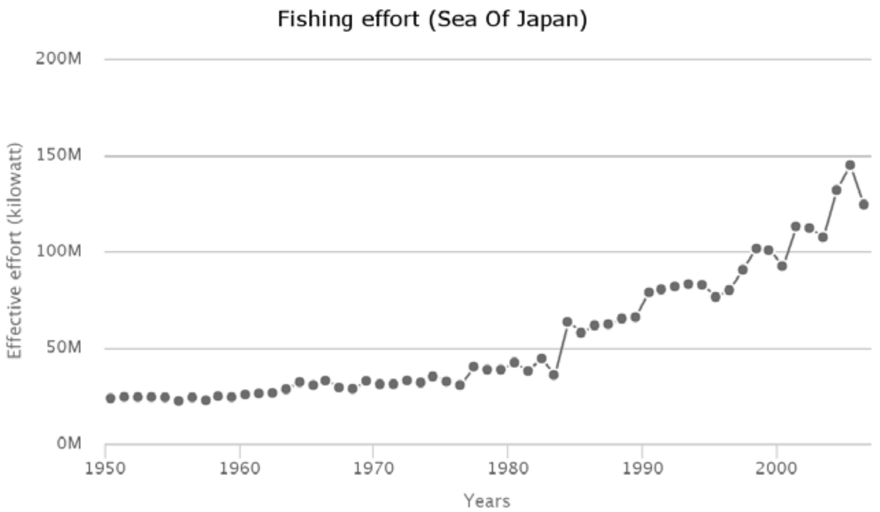
Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch decreased from around 16% in the early 1950s to its lowest point at around 2% in 1987. Then, this percentage kept increasing and reached its peak at 19% in 2001. It fluctuated around 18% in recent decade.



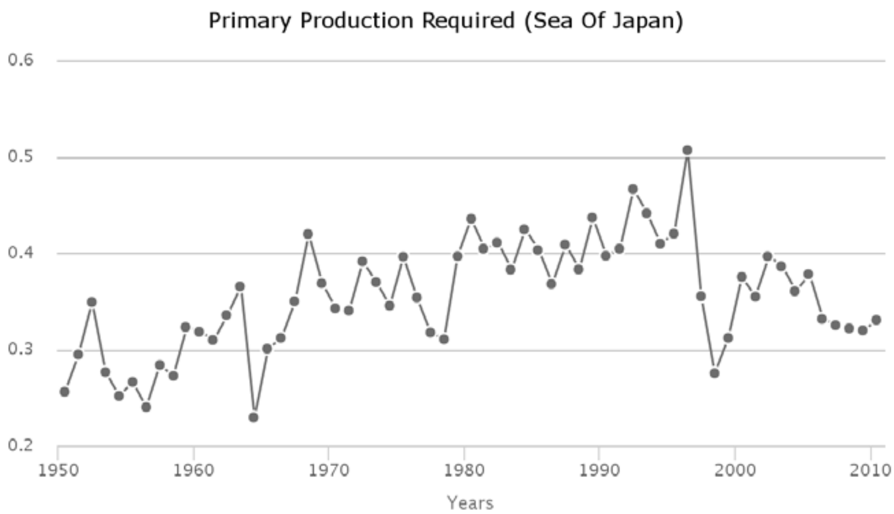
Fishing effort

The total effective effort continuously increased from around 24 million kW in the 1950s to its peak around 145 million kW in 2005.



Primary Production Required

The primary production required (PPR) to sustain the reported landings in this LME reached 50% of the observed primary production in the 1990s but has since declined in recent years.



Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans.
An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was moderate (level 3 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was low (2). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was moderate (3). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
3	2	3	3	2	3	3	2	3

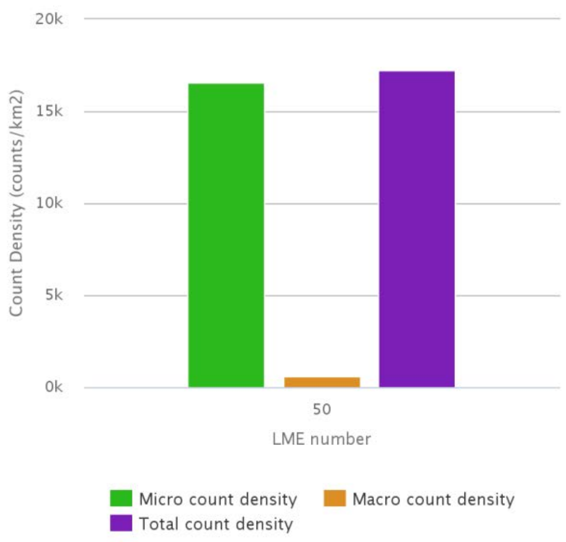
Legend: Very low, Low, Medium, High, Very high

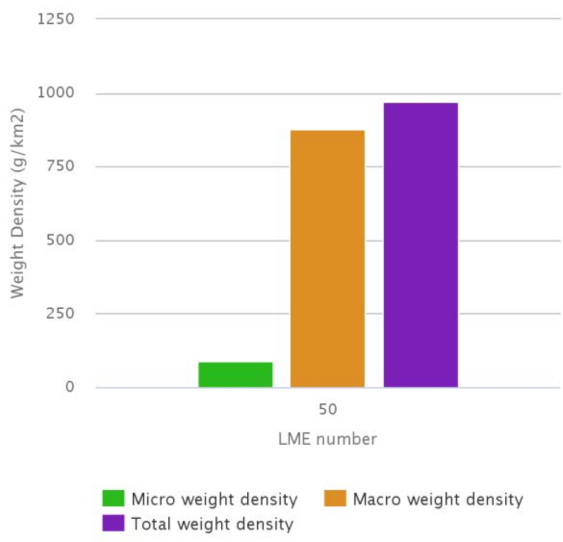
POPs

No pellet samples were obtained from this LME.

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with relatively high levels of plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The high values are due to the relative importance of these sources in this LME. The abundance of floating plastic in this category is estimated to be on average over 100 times higher that those LMEs with lowest values. There is moderate evidence from sea-based direct observations and towed nets to support this conclusion.





Ecosystem Health

Mangrove and coral cover

Not applicable.

Reefs at risk

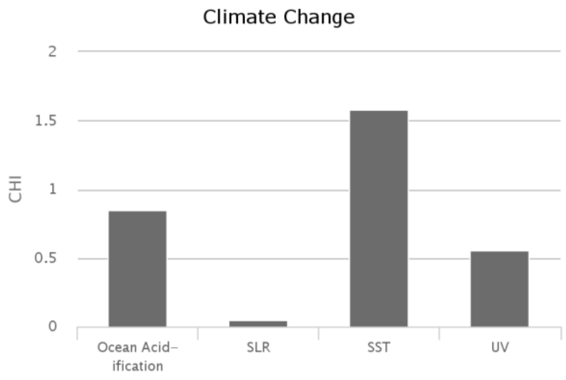
Not applicable.

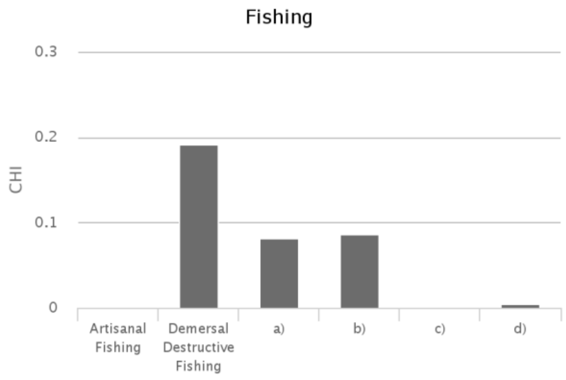
Marine Protected Area change

The Sea of Japan LME experienced an increase in MPA coverage from 4,065 km^2 prior to 1983 to 5,721 km^2 by 2014. This represents an increase of 40%, within the lowest category of MPA change.

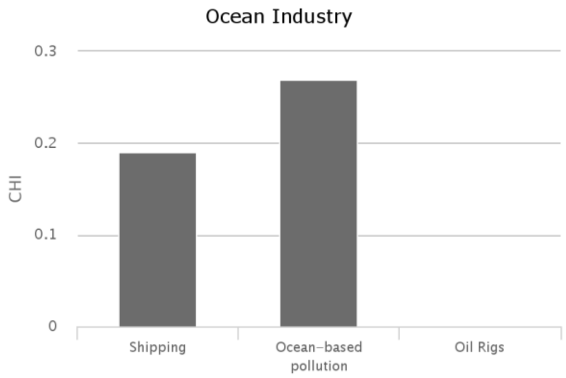
Cumulative Human Impact

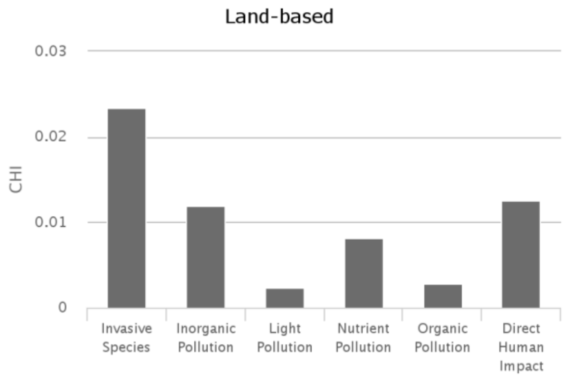
The Sea of Japan LME experiences above average overall cumulative human impact (score 3.91; maximum LME score 5.22), which is also well above the LME with the least cumulative impact. It falls in risk category 4 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (0.85; maximum in other LMEs was 1.20), UV radiation (0.55; maximum in other LMEs was 0.76), and sea surface temperature (1.58; maximum in other LMEs was 2.16). Other key stressors include commercial shipping, sea level rise, ocean based pollution, and all three types of demersal commercial fishing (demersal destructive, non-destructive low-bycatch, and non-destructive high-bycatch).





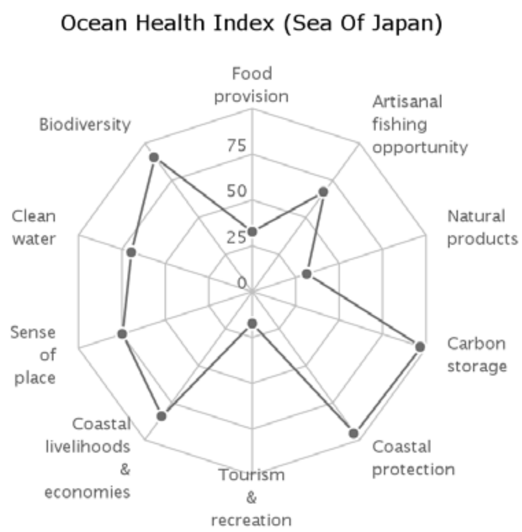
a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing





Ocean Health Index

The Sea of Japan LME scores below average on the Ocean Health Index compared to other LMEs (score 68 out of 100; range for other LMEs was 57 to 82). This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 remained unchange compared to the previous year. This LME scores lowest on food provision, natural products and tourism & recreation goals and highest on artisanal fishing opportunities, coastal protection, carbon storage, coastal economies, and habitat biodiversity goals. It falls in risk category 4 of the five risk categories, which is a relatively high level of risk (1 = lowest risk; 5 = highest risk).



OHI: 65.1

Very low	Low	Medium	High	Very high
	▲			

Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 511,094 km^2. A current population of 73 157 thousand in 2010 is projected to decrease to 55 696 thousand in 2100, with a density of 143 persons per km^2 in 2010 decreasing to 109 per km^2 by 2100. About 28% of coastal population lives in rural areas, and is projected to slightly decrease in share to 27% in 2100.

Total population		Rural population	
2010	**2100**	**2010**	**2100**
73,156,955	55,696,060	20,687,130	14,794,886

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 14% of the LME's coastal dwellers. This LME places in the low-risk category based on percentage and in the high-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
10,135,039

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the very high-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $2 353 million for the period 2001-2010. Fish protein accounts for 37% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$80 112 million places it in the high-revenue category. On average, LME-based tourism income contributes 7% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with medium risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
2,353,242,447	36.9	80,112,423,060	6.6	0.7218

Legend: Very low, Low, Medium, High, Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the very high HDI and very low-risk category. Based on an HDI of 0.882, this LME has an HDI Gap of 0.118, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a high-risk category (low HDI) because of reduced income levels and population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.8823	0.8938	0.6718

Legend: Very low, Low, Medium, High, Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (e.g. overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

Present day climate threat index of this LME is within the medium-risk (medium threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is high. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and increases to medium under a fragmented world development pathway.

2010		2100	
Climate Threat	**Contemporary Threat**	**SSP1**	**SSP3**
0.6036	0.3506	0.3908	0.5563

Legend:
Very low; Low; Medium; High; Very high

Governance

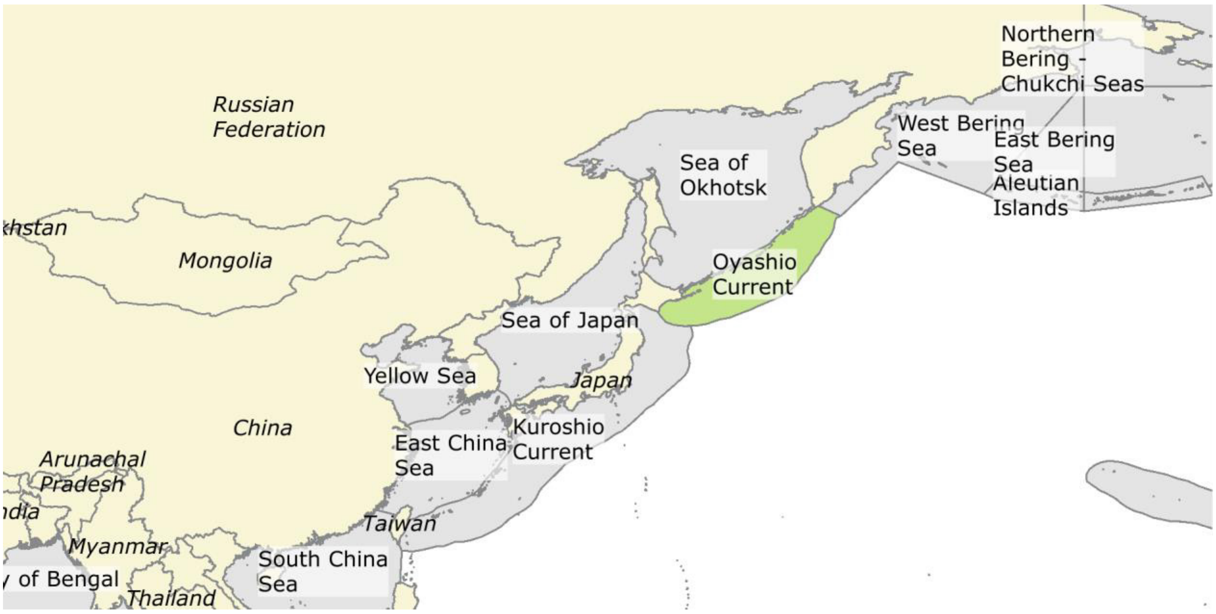
Governance architecture

In this LME, there is essentially no transboundary fisheries arrangement. However, PICES does provide opportunity for transboundary cooperation in assessment in science. The fact that there is no Regional Seas convention covering the area, only an action plan seriously weakens capacity for transboundary governance in areas relating to biodiversity and pollution. There is the potential for integration of pollution and biodiversity issues under NOWPAP should it proceed to the level of a Convention. There does not appear to be any organisation other than NOWPAP that could integrate and coordinate across the full range of issues required for EBM.
The overall scores for ranking of risk were:

Engagement	Completeness	Integration
88	**30**	**0.5**

Legend:
Very low; Low; Medium; High; Very high

LME 51 – Oyashio Current



Bordering countries: Japan, Russian Federation.
LME Total area: 663609 km^2

List of indicators

LME overall risk

This LME falls in the cluster of LMEs that exhibit low to medium levels of economic development (based on the night light development index) and medium levels of collapsed and overexploited fish stocks.

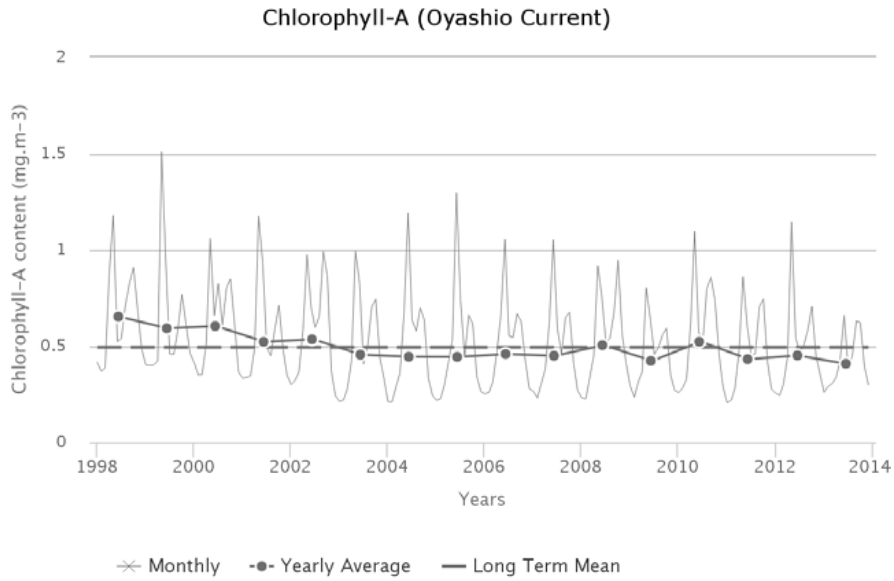
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is low..

Very low	Low	Medium	High	Very high
	▲			

Productivity

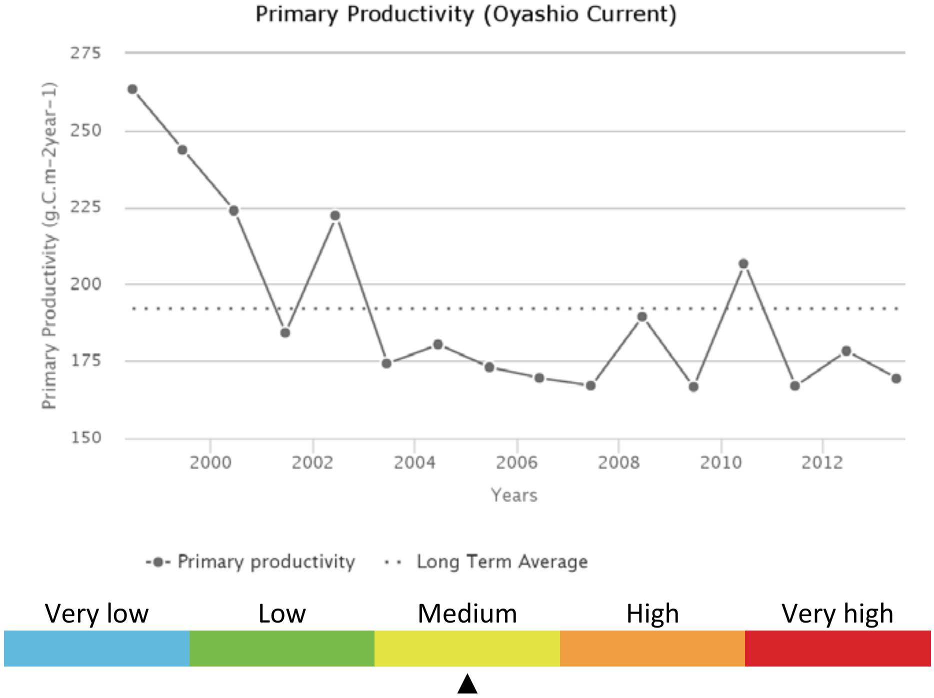
Chlorophyll-A

The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.871 $mg.m^{-3}$) in May and a minimum (0.255 $mg.m^{-3}$) during February. The average CHL is 0.493 $mg.m^{-3}$. Maximum primary productivity (263 $g.C.m^{-2}.y^{-1}$) occurred during 1998 and minimum primary productivity (167 $g.C.m^{-2}.y^{-1}$) during 2009. There is a statistically significant decreasing trend in Chlorophyll of -8.07 % from 2003 through 2013. The average primary productivity is 192 $g.C.m^{-2}.y^{-1}$, which places this LME in Group 3 of 5 categories (with 1 = lowest and 5= highest).



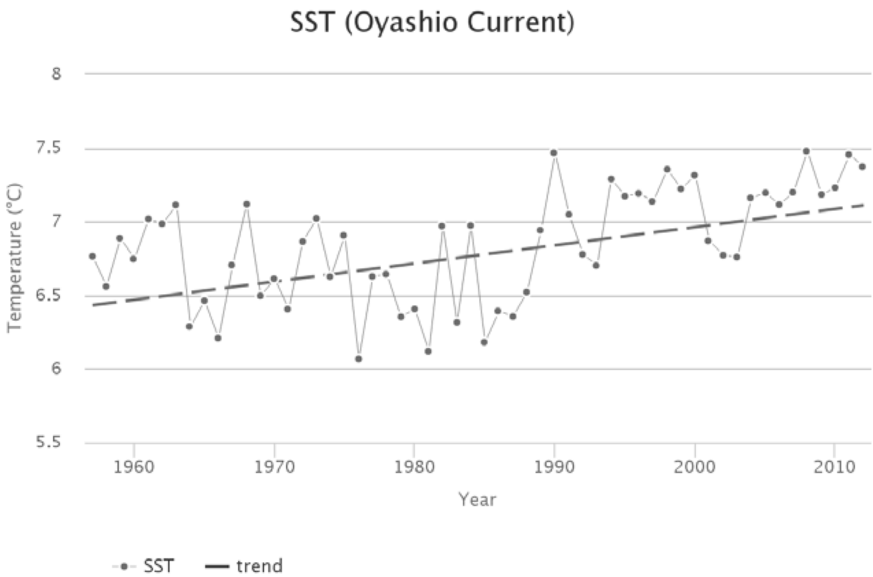
Very low	Low	Medium	High	Very high
		▲		

Primary productivity



Sea Surface Temperature

From 1957 to 2012, the Oyashio Current LME #51 has warmed by 0.68°C, thus belonging to Category 3 (moderate warming LME). The thermal history of this LME is somewhat similar to those of the East China Sea and Kuroshio Current. It consists of two regimes, cold and warm. The cold regime lasted through 1985-1987. The abrupt SST increase in the late 1980s resulted in the all-time maximum of almost 7.5°C in 1990, a 1.3°C increase in just 5 years. The well-documented trans-Pacific regime shift in 1976-1977 (Hare and Mantua, 2000) was not apparent in the Oyashio Current LME, even though the SST reached its absolute minimum in 1976. On the opposite, the next trans-Pacific regime shift, of 1988-1989 (Hare and Mantua, 2000), was pronounced, even dramatic, in the Oyashio Current LME. The long-term warming along the Oyashio Current and associated Polar Front was pronounced in winter, when SST rose at a rate of 1°C/decade, whereas in summer the long-term warming was negligible (Belkin et al., 2002).

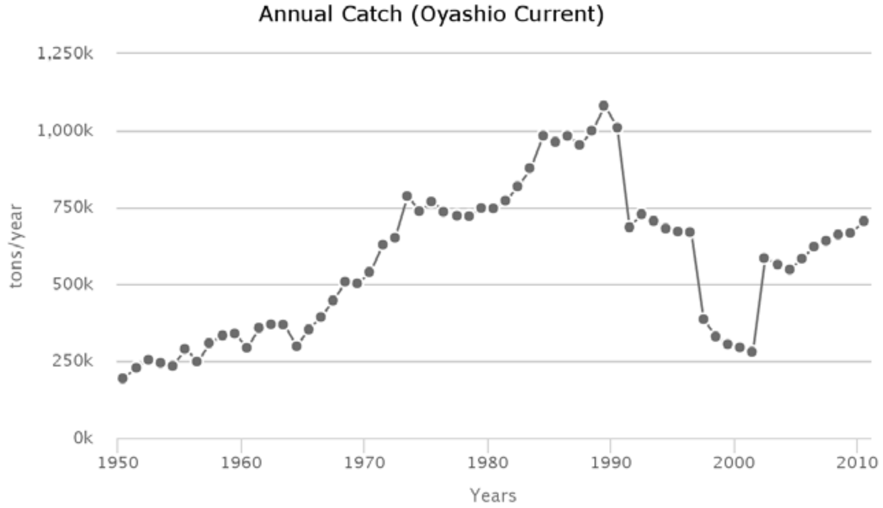


Fish and Fisheries

The Oyashio Current off the Pacific coast of the Kuril Islands is among the world's most productive marine areas and Russia's largest fishing ground.

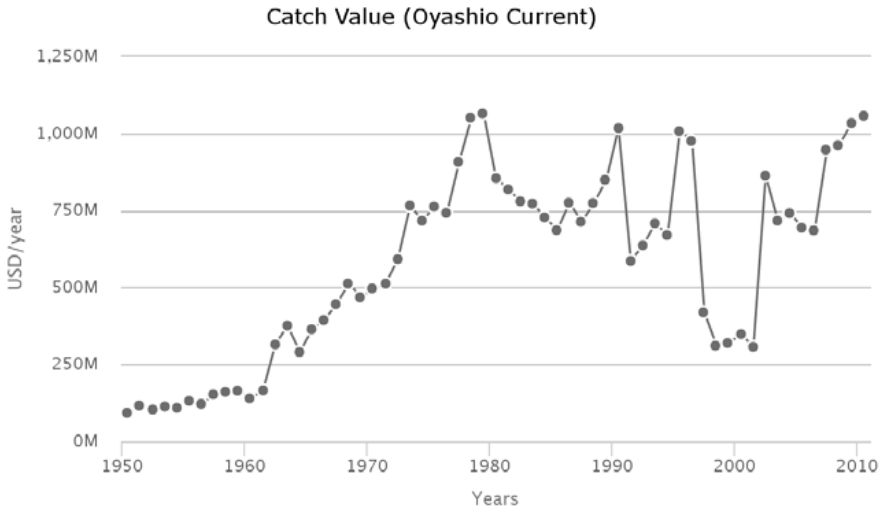
Annual Catch

Total reported landings in the LME exceeded 1 million t in the 1989, with large catch of Alaska pollock and Pacific sardine, but recorded around 600,000 t in the recent decade.



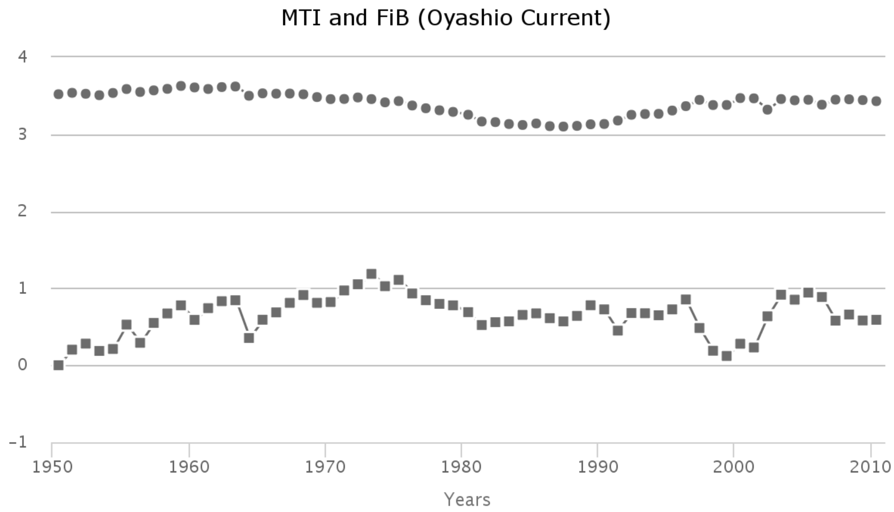
Catch value

The reported value of the landings had a peak of 1 billion US$ (in 2005 real US$) recorded in 1979.



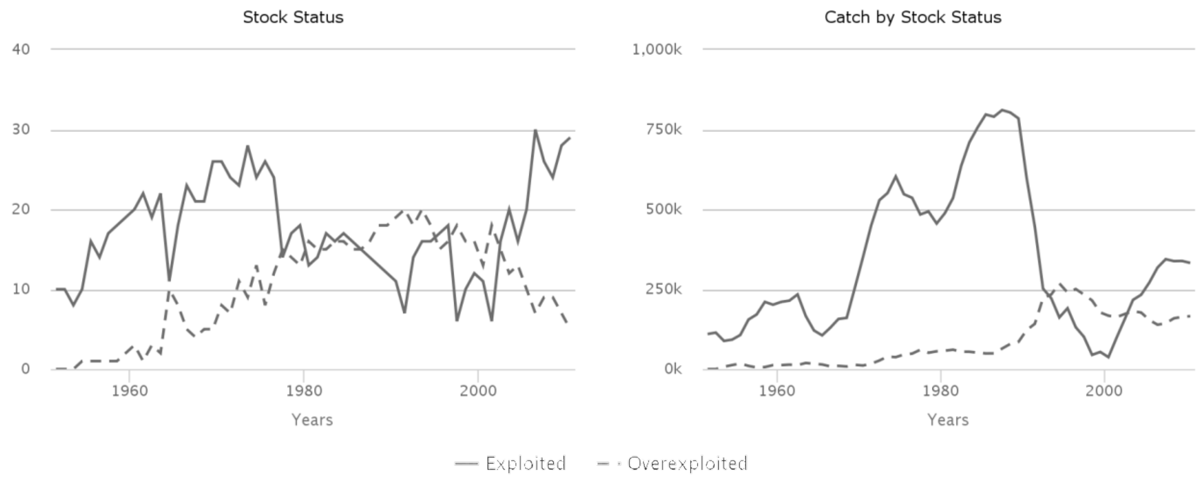
Marine Trophic Index and Fishing-in-Balance index

The MTI shows large fluctuations, reflecting the cyclic nature in the relative abundance, and hence the landings, of Pacific sardine. The FiB index shows a period of expansion in the 1950s and 1970s. Then, the FiB index declines from mid 1970s to early 1980s, after which the index levels off until late 1990s, indicating that the decrease in the mean trophic level resulting from the high proportion of Pacific sardine in the reported landings in the 1980s was compensated for by its large landings.



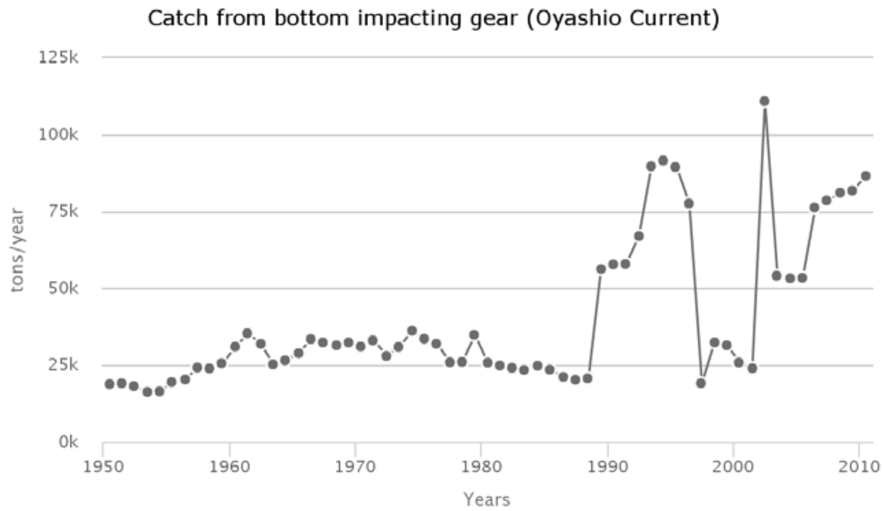
Stock status

The Stock-Catch Status Plots indicate that the number of fully exploited stocks have been rapidly increasing, accounting for 50% of the commercially exploited stocks in the few recent years, with an additional 25% of the stocks being either collapsed or overexploited. Overexploited stocks contributed 30% of the catch biomass in 2010.



Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch decreased from around 7% in the 1950s to its lowest point at around 2% in 1987. Then, this percentage kept increasing and reached its peak at 19% in 2001. The percentage fluctuated around 12% in recent decade.

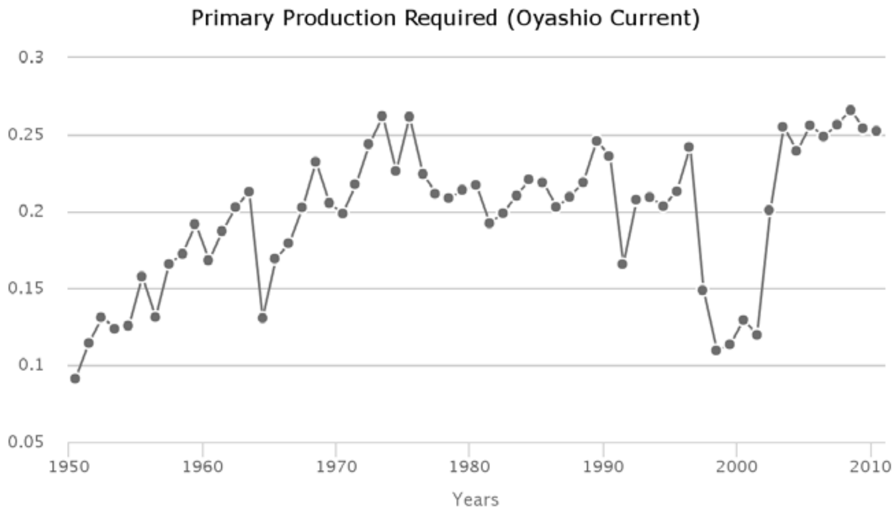


Fishing effort

The total effective effort continuously increased from around 2 million kW in the 1950s to its peak around 12.5 million kW in 2005.

Primary Production Required

The primary production required (PPR) to sustain the reported landings in this LME reached 25% of the observed primary production in the mid-1980s and in 1995, but has not reached such level since. With Russia selling the rights to fish inside its EEZ, a large number of foreign fleets, mainly those from China and South Korea, as well as a number of flag of convenience vessels operate within the LME.



Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans.

An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was very low. (level 1 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was very low (1). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

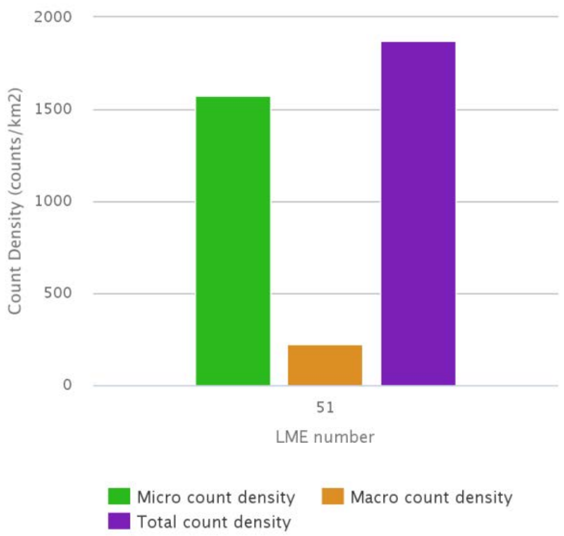
The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions very low (1). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

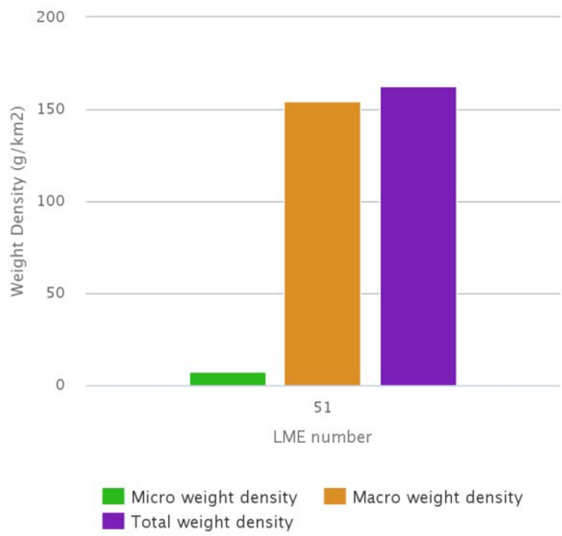
2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
1	1	1	1	1	1	1	1	1

Legend: Very low, Low, Medium, High, Very high

POPs
No pellet samples were obtained from this LME.

Plastic debris
Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with relatively low levels of plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The low values are due to the relative remoteness of this LME from significant sources of plastic. The abundance of floating plastic in this category is estimated to be on average over 40 times lower that those LMEs with the highest values. There is very limited evidence from sea-based direct observations and towed nets to support this conclusion.





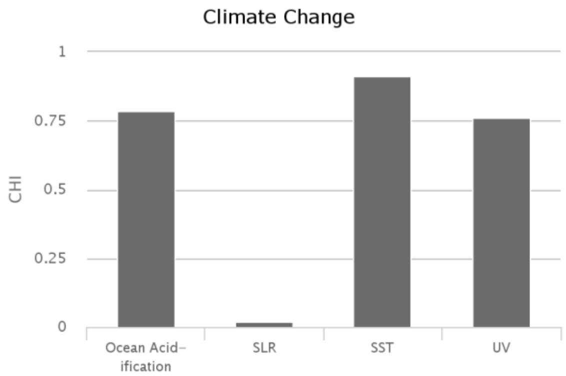
Ecosystem Health

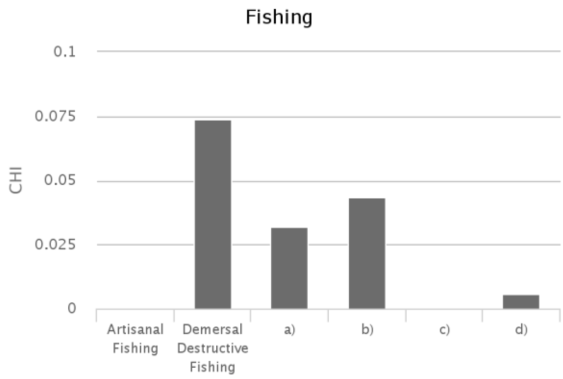
Mangrove and coral cover
Not applicable.

Reefs at risk
Not applicable.

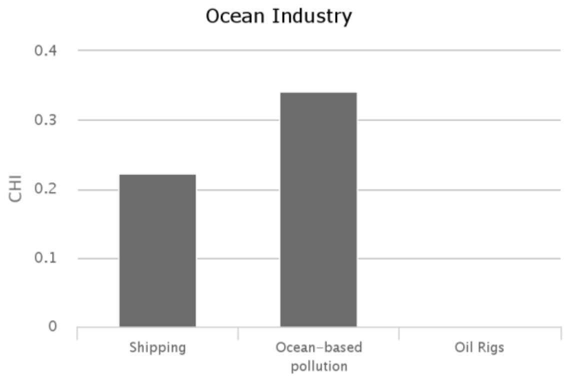
Marine Protected Area change
The Oyashio Current LME experienced an increase in MPA coverage from 466 km^2 prior to 1983 to 556 km^2 by 2014. This represents an increase of 19%, within the lowest category of MPA change.

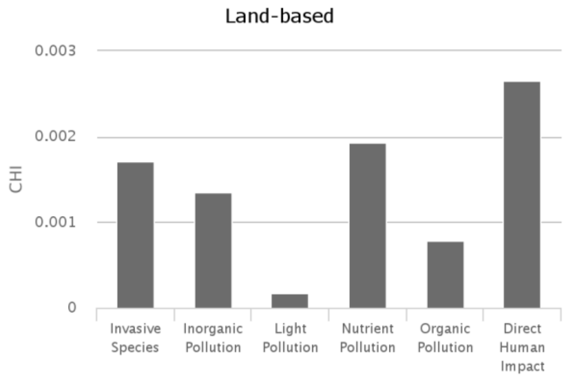
Cumulative Human Impact
The Oyashio Current LME experiences below average overall cumulative human impact (score 3.21; maximum LME score 5.22), but which is still well above the LME with the least cumulative impact. It falls in risk category 2 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (0.78; maximum in other LMEs was 1.20), UV radiation (0.76; maximum in other LMEs was 0.76), and sea surface temperature (0.91; maximum in other LMEs was 2.16). Other key stressors include commercial shipping, ocean based pollution, and all three types of demersal commercial fishing (demersal destructive, non-destructive low-bycatch, and non-destructive high-bycatch).

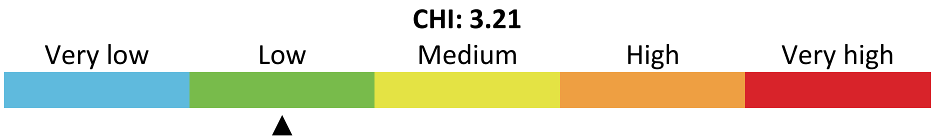




a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing

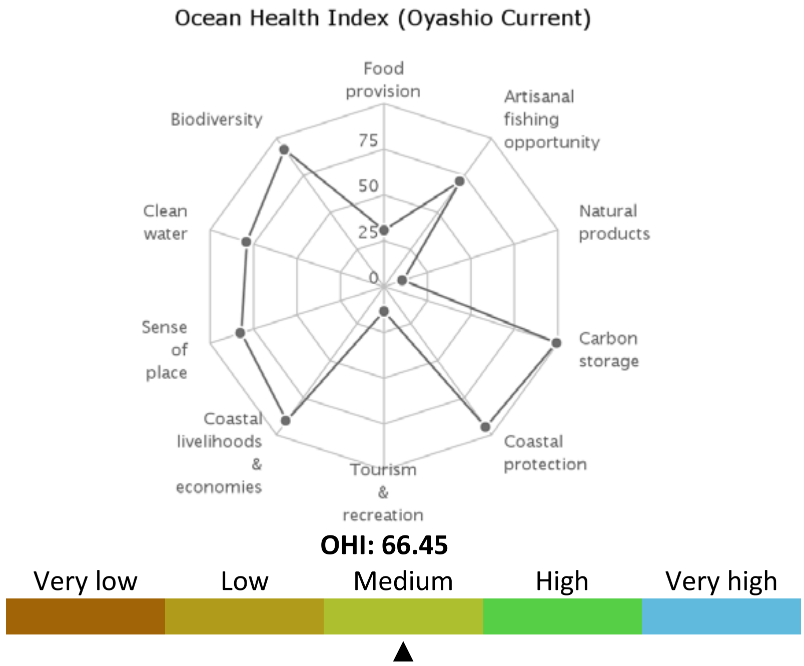






Ocean Health Index

The Oyashio Current LME scores below average on the Ocean Health Index compared to other LMEs (score 68 out of 100; range for other LMEs was 57 to 82). This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 decreased 1 point compared to the previous year, due in large part to changes in the score for clean waters. This LME scores lowest on food provision, natural products, and tourism & recreation goals and highest on artisanal fishing opportunities, coastal protection, carbon storage, ecoastal economies, lasting special places, and habitat biodiversity goals. It falls in risk category 4 of the five risk categories, which is a relatively high level of risk (1 = lowest risk; 5 = highest risk).



Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 37 156 km^2. A current population of 999 thousand in 2010 is projected to decrease to 412 thousand in 2100, with a density of 27 persons per km^2 in 2010 decreasing to 11 per km^2 by 2100. About 62% of coastal population lives in rural areas, and is projected to maintain this share in 2100.

Total population		Rural population	
2010	2100	2010	2100
999,018	412,377	620,316	255,921

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 16% of the LME's coastal dwellers. This LME places in the high-risk category based on percentage and in the low-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
159,494

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the high-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $952 million for the period 2001-2010. Fish protein accounts for 37% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$14 149 million places it in the low-revenue category. On average, LME-based tourism income contributes 7% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with low risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
952,399,462	36.9	14,148,758,052	6.7	0.7059

Legend: Very low | Low | Medium | High | Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the very high HDI and very low-risk category. Based on an HDI of 0.883, this LME has an HDI Gap of 0.117, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a medium-risk category (medium HDI) because of reduced income levels and population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.8832	0.9798	0.7525

Legend: Very low | Low | Medium | High | Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (e.g. overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

Present day climate threat index of this LME is within the medium-risk (medium threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is medium. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and remains very low under a fragmented world development pathway.

2010		**2100**	
Climate Threat	**Contemporary Threat**	**SSP1**	**SSP3**
0.5404	0.3209	0.1957	0.4424

Legend:

Very low Low Medium High Very high

Governance

Governance architecture

In this LME, there is essentially no transboundary fisheries arrangement. However, PICES does provide opportunity for transboundary cooperation in assessment and science. Also, the fact that there is no Regional Seas convention covering the area, but only an action plan (NOWPAP), seriously weakens capacity for transboundary governance in areas relating to pollution. Further, there is no indication of transboundary integration between the fisheries and pollution issues, other than through cooperation in science. There is the potential for integration of pollution and biodiversity issues under NOWPAP should it proceed to the level of a Convention. There does not appear to be any other organisation than NOWPAP that could integrate and coordinate across the full range of issues required for EBM.

The overall scores for ranking of risk were:

Engagement	Completeness	Integration
100	**30**	**0.3**

Legend:

Very low Low Medium High Very high

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The water systems of the world – aquifers, lakes, rivers, large marine ecosystems, and open ocean- sustain the biosphere and underpin the socioeconomic wellbeing of the world's population. Many of these systems are shared by two or more nations. These transboundary waters, stretching over 71% of the planet's surface, in addition to the subsurface aquifers, comprise humanity's water heritage.

Recognizing the value of transboundary water systems and the reality that many of them continue to be degraded and managed in fragmented ways, the Global Environment Facility Transboundary Waters Assessment Programme (GEF TWAP) was developed. The Programme aims to provide a baseline assessment to identify and evaluate changes in these water systems caused by human activi es and natural processes, and the consequences these may have on dependent human populations. The institutional partnerships forged in this assessment are envisioned to seed future transboundary assessments as well.

The final results of the GEF TWAP are presented in the following six volumes:
Volume 1 – ***Transboundary Aquifers and Groundwater Systems of Small Island Developing States: Status and Trends***
Volume 2 – ***Transboundary Lakes and Reservoirs: Status and Trends***
Volume 3 – ***Transboundary River Basins: Status and Trends***
Volume 4 – ***Large Marine Ecosystems: Status and Trends***
Volume 5 – ***The Open Ocean: Status and Trends***
Volume 6 – ***Transboundary Water Systems: Crosscutting Status and Trends***

A *Summary* for Policy Makers accompanies each volume. All TWAP publications are available for download at http://www.geftwap.org

This annex – Transboundary waters: A Global Compendium, Water System Information Sheets: Eastern & Central Asia, Volume 6-Annex J -- is one of 12 annexes to the Crosscutting Analysis discussed in Volume 6. The global compendium organized into 14 TWAP regions, compiles information sheets on 765 international water systems including the baseline values of quantitative indicators that were used to establish contemporary and relative risk levels at system and regional scales. On the long term, it is envisioned that these baseline information sheets continue to be updated by future assessments at multiple spatial and temporal scales to better track the changing states of transboundary waters that are essential in sustaining human wellbeing and ecosystem health.

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