TWAP
TRANSBOUNDARY WATERS ASSESSMENT PROGRAMME

Transboundary Waters: A Global Compendium

Water System Information Sheets: Southern & Southeastern Asia

Volume 6 - Annex I: Southern & Southeastern Asia

UNEP

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Volume 6-Annex I

Transboundary Waters: A Global Compendium

Water System Information Sheets: Southern & Southeastern Asia

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FORMIN.FINLAND.FI

MINISTRY FOR FOREIGN AFFAIRS OF FINLAND

Acknowledgements

Assessment Team: Transboundary Aquifers

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

igrac – International Groundwater Resources Assessment Centre

Goethe Universität Frankfurt am Main

SFU – Simon Fraser University – Engaging the World

Assessment Team: Transboundary Lake Basins & Reservoirs

ILEC

The Meadows Center for Water and the Environment – Texas State University

Shiga University

Assessment Team: Transboundary River Basins

UNEP-DHI Partnership – Centre on Water and Environment – UNEP – DHI

Global Change – IGBP – 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 Change – IGBP – 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

Dalhousie University – Inspiring Minds

Project Coordinating Unit: Transboundary Waters Assessment Programme

UNEP

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FORMIN.FINLAND.FI – Ministry for Foreign Affairs of Finland

Compendium Editor: Liana Talaue McManus, TWAP Project Manager

Lead Authors, Crosscutting Analysis (Volume 6): Liana Talaue McManus (TWAP Project Manager), **Robin Mahon** (Centre for Resource Management and Environmental Studies, University of the West Indies, Barbados) (Co-Chairs, TWAP Crosscutting Analysis Working Group).

Members, Crosscutting Analysis Working Group:

Name, TWAP Component	Primary affiliation
Alice Aureli, *Aquifers Component Principal*	UNESCO International Hydrologic Programme (IHP), Paris, France
Leszek Bialy, *Aquifers (Former) Component Coordinator*	UNESCO International Hydrologic Programme (IHP), Paris, France
Julian Barbiére, *Large Marine Ecosystems (LMEs) Component Principal*	UNESCO Intergovernmental Oceanographic Commission, Paris, France
Maija Bertule, *Rivers Component*	UNEP-DHI Partnership Centre on Water and Environment, Denmark
Emanuele Bigagli, *Open Ocean Component*	UNESCO Intergovernmental Oceanographic Commission, Paris, France
Peter Bjørnsen, *Rivers Principal*	UNEP-DHI Partnership Centre on Water and Environment, Denmark
Bruno Combal, *LMEs and Open Ocean Components*	UNESCO Intergovernmental Oceanographic Commission, Paris, France
Aurélien Dumont, *Aquifers Component*	UNESCO International Hydrologic Programme (IHP), Paris, France
Lucia Fanning, *Co-Chair Governance Crosscutting Working Group*	Marine Affairs Program, Dalhousie University, Canada
Albert Fischer, *Principal* and *(Current) Open Ocean Component Coordinator*	UNESCO Intergovernmental Oceanographic Commission
Paul Glennie, *Rivers Component Coordinator*	UNEP-DHI Partnership Centre on Water and Environment, Denmark
Sarah Grimes, *(Former) Open Ocean Component Coordinator*	University of Geneva
Sherry Heileman, *LMEs Component Coordinator*	UNESCO Intergovernmental Oceanographic Commission, Paris, France
Pierre Lacroix, *Data and Information and Crosscutting Working Group*	University of Geneva
Matthew Lagod, *(Current) Aquifers Component Coordinator*	UNESCO International Hydrologic Programme (IHP), Paris, France
Masahisa Nakamura, *Lakes Component*	Research Center for Sustainability and Environment, Shiga University, Japan
Geert-Jan Nijsten, *Aquifers Component*	International Groundwater Centre (IGRAC)
Walter Rast, *Lakes Principal and Component Coordinator*	The Meadows Center for Water and the Environment, Texas State University, USA
Alex de Sherbinin, *Rivers Component*	Center for International Earth Science Information Network, Columbia University, New York, USA

Science communication: Nieves Izquierdo Lopes and Janet Skaalvik (GRID-ARENDAL)

UNEP Secretariat: Liana Talaue McManus (Project Manager), Joana Akrofi, Kaisa Uusimaa (UNEP/DEWA) and Isabelle van der Beck (Task Manager)

Design and layout: Audrey Ringler (UNEP), Jennifer Odallo (UNON), Paul Odhiambo (UNON)

GIS: Jane Muriithi (UNEP/DEWA)

Central Data Portal: Pierre Lacroix and Andrea de Bono (GRID-Geneva)

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 I)

Southern Asia (Part A)

Southeastern Asia (Part B)

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.

Transboundary Waters: A Global Compendium

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:

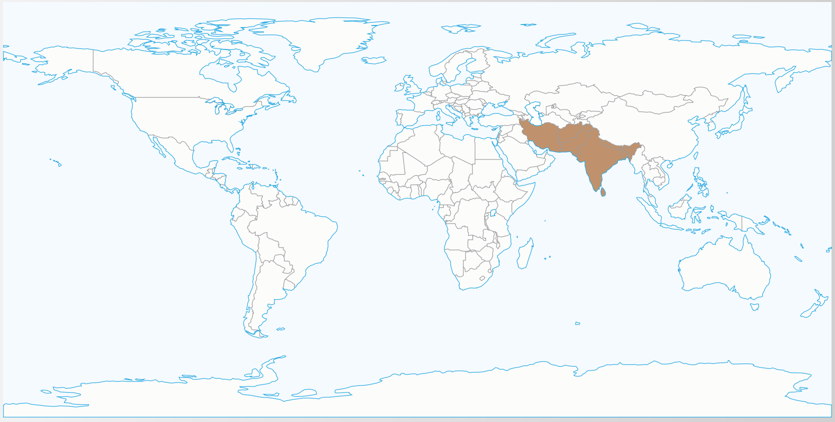
Transboundary Aquifers: http://twapviewer.un-igrac.org
Transboundary Lakes/ Reservoirs: http://ilec.lakes-sys.com/
Transboundary River Basins: http://twap-rivers.org
Large Marine Ecosystems: http://onesharedocean.org
Open Ocean: http://onesharedocean.org

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

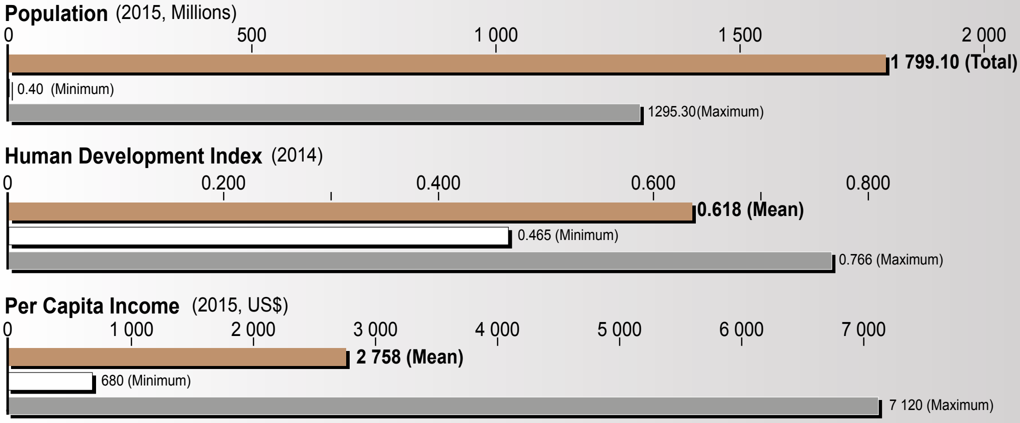
Over the long term, it is envisioned that these baseline information sheets will continue to be updated by future assessments at multiple spatial and temporal scales to better track the changing states of transboundary waters that are essential in sustaining human wellbeing and ecosystem health.

Regional Risks by Theme

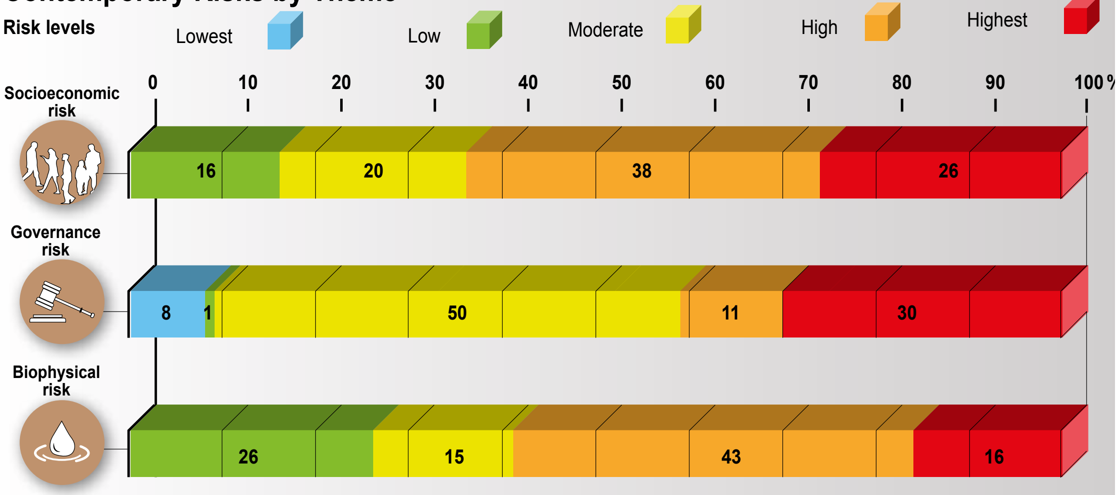
TRANSBOUNDARY WATERS: SOUTHERN ASIA



The region has an average Human Development Index of 0.618, belonging to the Medium HDI group with a total population of 1800 million in 2015. Contemporary risks of water systems by water category and theme expressed as percentages are shown at top right. Pooling across 30 transboundary water systems in the region (bottom left), 38% of the water systems are at high socioeconomic risk, 60% are subject to moderate governance risk, and 43% are at high biophysical risk. On average, the region's transboundary waters (bottom right) are subject to high socioeconomic, moderate governance and moderate biophysical risks. Transboundary river basins and LMEs are at high risk; aquifers are at moderate risk and lakes are at low risk, across all risk themes.

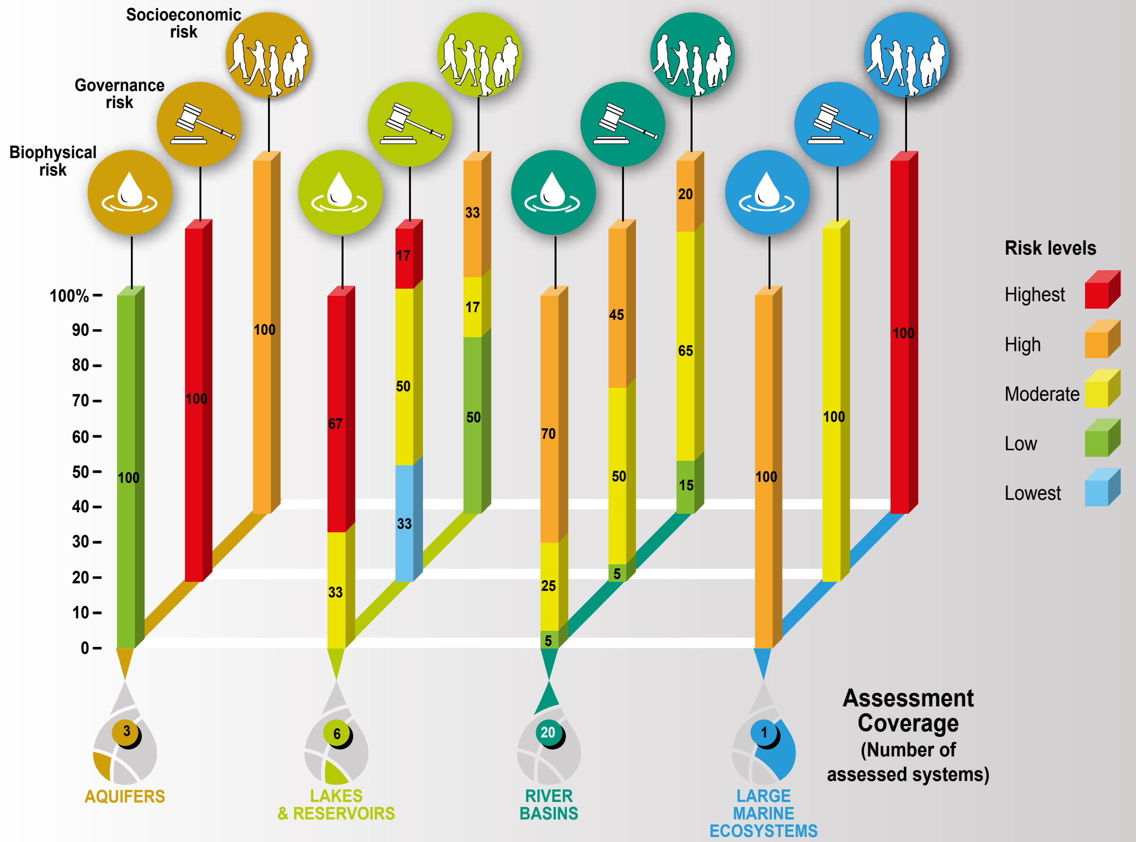


Contemporary Risks by Theme

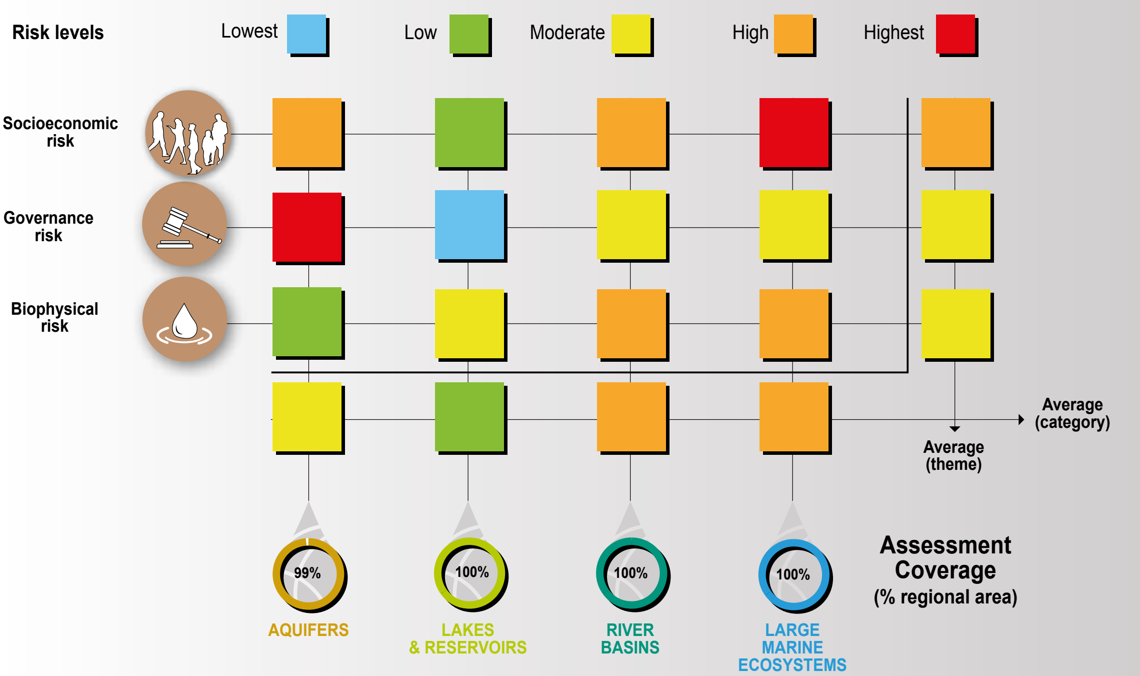


Regional Risks by Water Category

Contemporary Risks by Water Category



Average Risks



1. East Ganges River Plain Aquifer
2. Indus River Plain Aquifer
3. South of Outer Himalayas Aquifer

AS80 – East Ganges River Plain Aquifer

Geography

Total area TBA (km^2): 180 000

No. countries sharing: 2

Countries sharing: Bangladesh, India

Population: 230 000 000

Climate Zone: Humid Subtropical

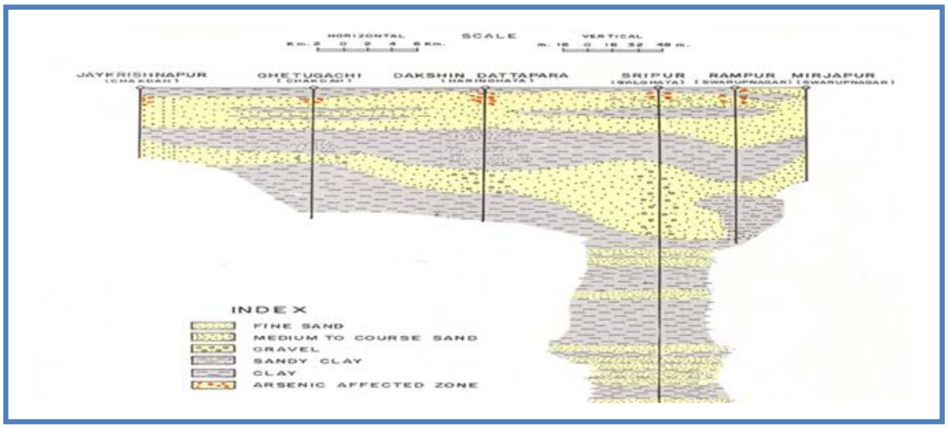
Rainfall (mm/yr): 1900

Hydrogeology

Aquifer type: Multiple 3-layered hydraulically connected system

Degree of confinement: Mostly confined but some parts unconfined

Main Lithology: Sediment – sand



Schematic cross-section Chakdah Swarupnagar Tract Nadia North 24- Parganas Districts, West Bengal (Ganga Basin)

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

AS80 – East Ganges River Plain 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)
Bangladesh							1400		D	
India	<1	<1	70		2	B	1100			
TBA level							**1300**			

(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)				
Bangladesh	380	320	-18	-24	55	45	62	7
India	330	290	-16	-22	36	16	52	12
TBA level	**360**	**310**	**-17**	**-23**	**46**	**31**	**58**	**11**

	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)
Bangladesh	4	1200	25	37	48	8	18
India	5	1200	23	34	51	8	12
TBA level	**4**	**1200**	**24**	**36**	**49**	**8**	**16**

AS80 – East Ganges River Plain 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)
Bangladesh	<5	<5	400	Aquifer mostly confined, but some parts unconfined	Sediment - Sand	High primary porosity fine/ medium sedimentary deposits		1500
India	10	7	600	Aquifer mostly confined, but some parts unconfined				4500
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 aquifer is a multiple 3-layered hydraulically connected system that is mostly confined but some parts unconfined. The average depth to the water table varies between <5 m (Bangladesh) and 10m (India). The average depth to the top of the aquifer varies from <5 m (Bangladesh) to 7 m (India) while the average thickness of the aquifer system is between 400 m (Bangladesh) and 600m (India).

Hydrogeological aspects

The predominant aquifer lithology is sediment – sand that has a high primary porosity with a high horizontal and a low vertical connectivity. The average transmissivity value varies between 1 500 m^2/d and 4 500 m^2/d. The total groundwater volume within the system in India is 4253 km^3. The average amount of recharge into the system within India should be reviewed. There are extreme recharge events but no data is available for average extreme amounts. A significant portion of the recharge is not through natural causes but is through return flows from irrigated lands. The annual amount of groundwater depletion within India is 0.18 km^3 (2000 – 2010) that is probably due to over-pumping.

Linkages with other water systems

The predominant source of natural recharge is through precipitation over the aquifer area and through recharge from river flood plains. The major discharge mechanism is through river base flow and through groundwater flow into another aquifer.

Environmental aspects

Within India around 30% of the aquifer area is naturally unsuitable for human consumption over a significant part of the aquifer. This is mainly due to elevated salinity and due to excessive amounts of arsenic. Within Bangladesh a significant amount of anthropogenic groundwater pollution over extensive areas has occurred but this has not been quantified. Within India about 15% of the aquifer area is polluted over a significant part of the aquifer. The main causes are through municipalities, industrial waste disposal, and mining activities. Around 8 % of the aquifer within India is characterised

AS80 – East Ganges River Plain Aquifer

by shallow groundwater, whereas around 10% of the aquifer area is covered with groundwater dependent ecosystems.

Socio-economic aspects

A total amount of 39.20 Mm^3 of water was abstracted from the system during 2010 within India. No data is available on the total amount of fresh water that was abstracted over the aquifer area.

Legal and Institutional aspects

Currently there is no Transboundary Agreement with scope within Bangladesh.

Priority Issues

Due to a decrease of Transboundary River flow through excessive pumping / withdrawal from the aquifer, a declining groundwater table has resulted. This has also led to arsenic contamination and salinity encroachment. This matter needs to be addressed.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Sangam Shresta	Asian Institute of Technology	Thailand	sangamshrestha@gmail.com	Regional coordinator
Rahman Md Mizanur	Bangladesh Water Development Board	Bangladesh	mizanurbd2004@yahoo.com	Lead National Expert
Zahid Anwar	Bangladesh Water Development Board (BWDB)	Bangladesh	anwarzahidb@gmail.com	Contributing national expert
Devinder Kumar Chadha	Global Hydrogeological Solutions	India	devinderchadha27@gmail.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.

Both TBA countries contributed to the information. Information was adequate to describe the aquifer in general terms. Some quantitative information was also available, but this was not enough 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

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.

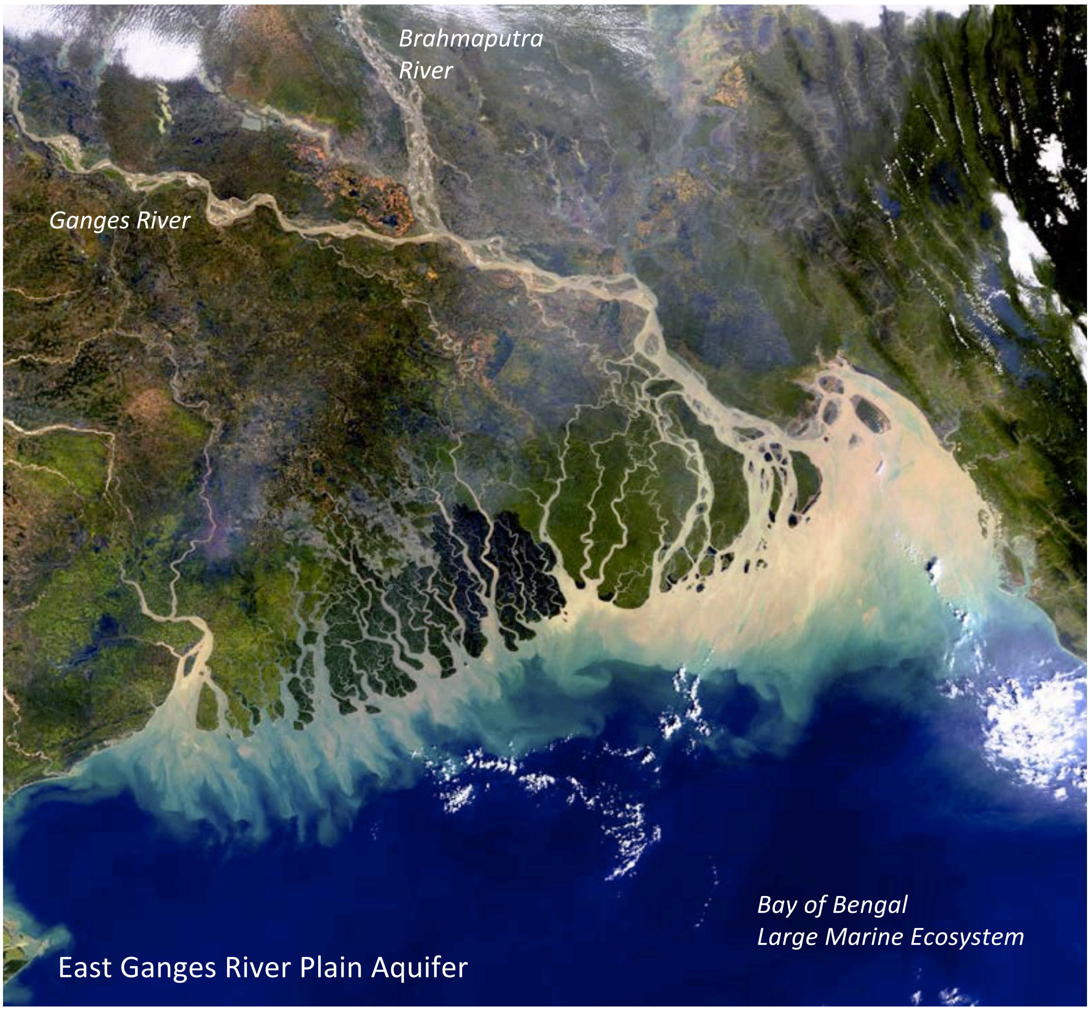
For more information on TWAP Groundwater and for more data, please have a look at the TWAP Groundwater Information Management System which is accessible via www.twap.isarm.org or www.un-igrac.org.

AS80 – East Ganges River Plain Aquifer

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



AS78 – Indus River Plain Aquifer

Geography

Total area TBA (km^2): 260 000

No. countries sharing: 2

Countries sharing: India, Pakistan

Population: 110 000 000

Climate Zone: Arid

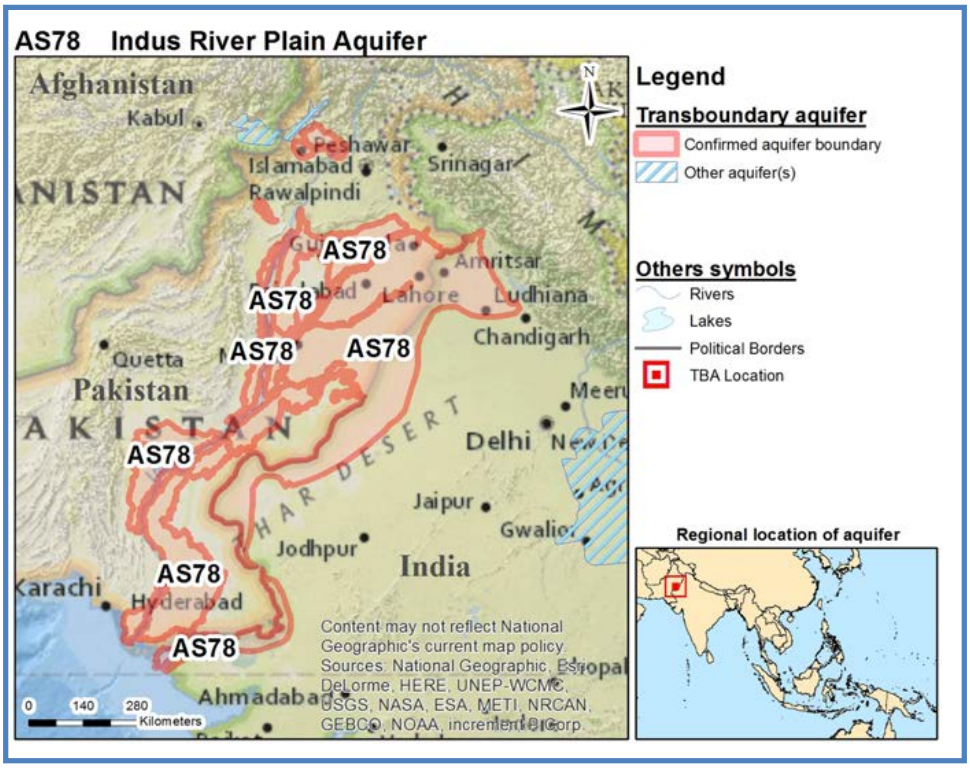
Rainfall (mm/yr): 280

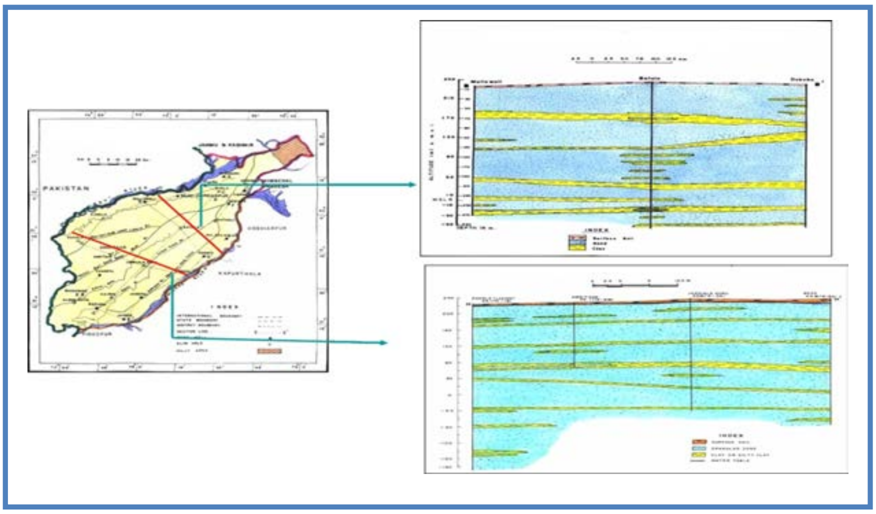
Hydrogeology

Aquifer type: Multiple layered hydraulically connected and single layer

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

Main Lithology: Sediment - Sand





Sub-surface lithological cross sections showing the configuration of aquifer zones

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

AS78 – Indus River Plain 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)
India	<1	<1	90		100		250			
Pakistan	<1	1	20	65	120		520	>1000	D	C
Disputed land*							420			
TBA level							**430**			

(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.

* To define country segments of the transboundary aquifers the country borders from FAO Global Administrative Unit Layers (2013) was used.

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)				
India	270	1000	-10	-20	35	71	32	66
Jammu and Kashmir	200	450	-16	-22	71	70	71	70
Pakistan	390	810	-27	-40	18	36	18	5
TBA level	**350**	**860**	**-24**	**-36**	**20**	**44**	**19**	**21**

AS78 – Indus River Plain Aquifer

	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)
India	28	260	27	4	35	10	18
Jammu and Kashmir	0	440	23	34	47	28	43
Pakistan	2	480	43	75	36	2	8
TBA level	**10**	**410**	**40**	**69**	**36**	**4**	**10**

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)
India	20	60	95	Aquifer mostly unconfined, but some parts confined				2500
Jammu and Kashmir								
Pakistan	9		200	Aquifer mostly unconfined, but some parts confined	Sediment - Sand	Primary porosity fine/ medium sedimentary deposits	No secondary porosity	3000
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 aquifer is a Multiple 3-layered hydraulically connected system in India but it is single layered within Pakistan. The aquifer is mostly unconfined, but some parts are confined. The average depth to the water table varies between 9 m in Pakistan and 20 m in India. The average depth to the top of the aquifer within India is 60 m and the average thickness of the aquifer system varies between 95 m (India) and 200 m (Pakistan).

Hydrogeological aspects

The predominant aquifer lithology is sediment – sand that has a high primary porosity with no secondary porosity. The formation is also characterised by a high horizontal connectivity. The average transmissivity value varies between 2 500m^2/d and 3 000 m^2/d (India, Pakistan). The total groundwater volume within the system is 1 622 km^3. The average recharge into the system is 62.85 Mm^3/yr and the

AS78 – Indus River Plain Aquifer

aerial extent of the major recharge area is over 507 000 km^2. During the drought periods the average amount of recharge drops to 51.44 Mm^3/yr (Pakistan). Within Pakistan only 25% of the recharge is from natural recharge processes. The long-term trend does indicate signs of groundwater depletion that is probably due to over-pumping and this amounts to 8.6 km^3/yr (India) and 20.3 km^3/yr (Pakistan).

Linkages with other water systems

The predominant source of recharge is through runoff into aquifer area within India and through human induced recharge within Pakistan. The major discharge mechanism is through river base flow within India and through evapotranspiration within Pakistan.

Environmental aspects

Around 10 % of the natural groundwater within India and 82 % within Pakistan are unsuitable for human consumption. This is only within the superficial layers within India but it is over a significant part of the aquifer within Pakistan. This is mainly as a result of elevated amounts of natural salinity and that also includes high levels of fluoride and arsenic within Pakistan. Some anthropogenic pollution has been identified within India where it is only over the superficial layers but the data is not available to determine the percentage of the aquifer area that has been affected. Within Pakistan a significant amount of pollution over the superficial layers has occurred and it is estimated to be the case in excess of 80 % of the aquifer. Within India 13 % of the aquifer has shallow groundwater whereas this increases to 37 % within Pakistan. In both countries <5 % of the aquifer area is covered with groundwater dependent ecosystems.

Socio-economic aspects

A total of 71 895 Mm^3 of water was abstracted from the system during 2010. A total amount of 110 805 Mm^3 of fresh water was abstracted over the aquifer area for the same year.

Legal and Institutional aspects

No Transboundary Agreement with Scope currently exists. Within Pakistan the national institution has a full mandate and capacity.

Priority Issues and Hotspots

The degradation in the water quality of a significant part of the aquifer due to pollution needs to be addressed. Other current problems include water logging & inland salinity, groundwater pollution (fluoride, nitrate, selective occurrence of arsenic), and over-exploitation. Groundwater mining is currently taking place in Bari Doab, due to desiccation of Ravi and Sutlej Rivers. The Indus River Commission is dealing only with surface water and groundwater should be included. A detailed study and groundwater investigation is required for the management and development of the transboundary aquifers. Due to heavy subsidies, groundwater levels are declining in Indian Punjab, resulting in possibility of transboundary groundwater flows. Currently the information is lacking, and knowing these possible flow directions is important for management of these transboundary resources.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Sangam Shresta	Asian Institute of Technology	Thailand	sangamshrestha@gmail.com	Regional coordinator
Devinder Kumar Chadha	Global Hydrogeological Solutions	India	devinderchadha27@gmail.com	Lead National Expert
Muhammad Basharat	Pakistan Water and Power Development Authority (WAPDA)	Pakistan	basharatm@hotmail.com	Contributing national expert

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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.

Two TBA countries contributed to the information. Information was adequate to describe the aquifer in general terms. The quantitative information that was made available 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

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:
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).

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AS79 – South of outer Himalayas Aquifer

Geography

Total area TBA (km^2): 310 000

No. countries sharing: 2

Countries sharing: India, Nepal

Population: 250 000 000

Climate Zone: Humid Subtropical

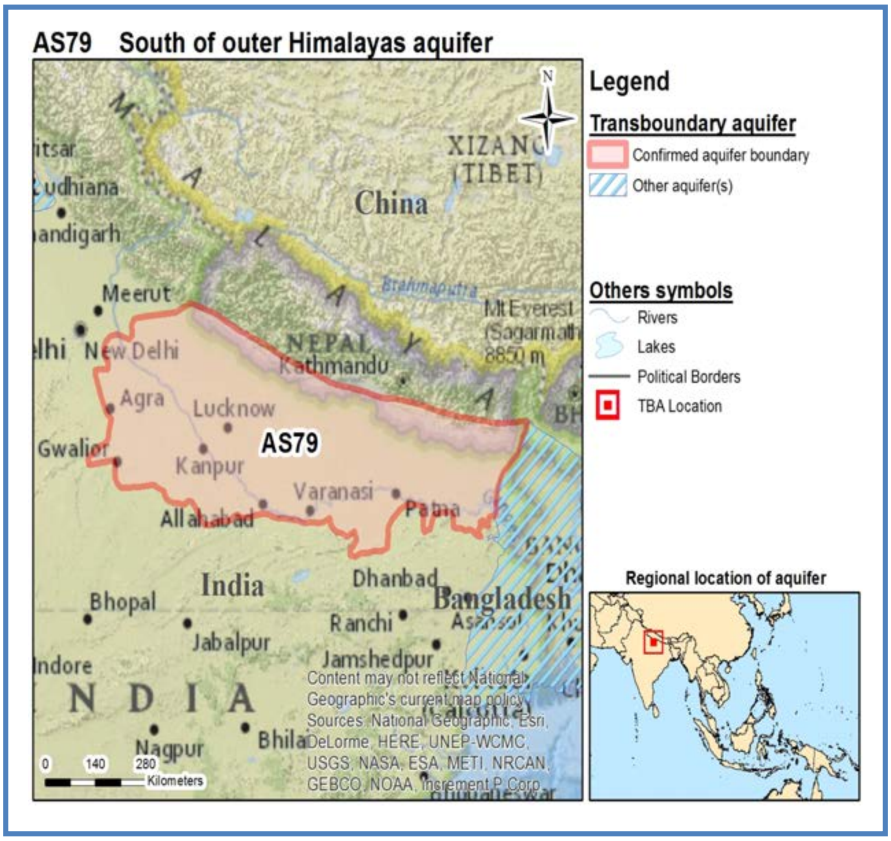
Rainfall (mm/yr): 1100

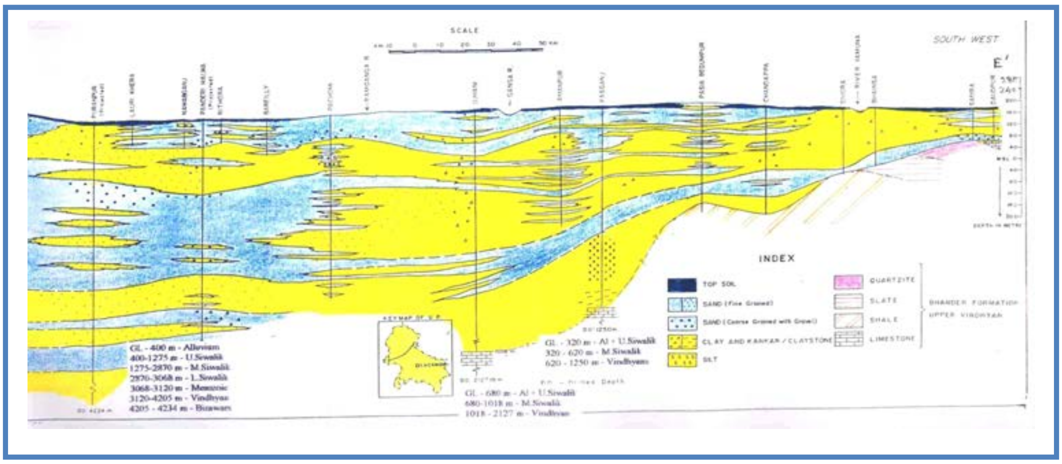
Hydrogeology

Aquifer type: Multiple-layered hydraulically connected

Degree of confinement: Mostly confined, but some parts unconfined

Main Lithology: Sediment – sand





Sub-surface cross-section of AS79 (India Portion)

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

AS79 – South of outer Himalayas 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)
India	<1	<1	90	<5	3		860	<5		
Nepal							420			
TBA level							**810**			

(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)				
India	240	270	-17	-23	45	26	54	23
Nepal	230	500	-23	-33	34	33	34	23
TBA level	**240**	**280**	**-17**	**-23**	**44**	**27**	**53**	**23**

	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)
India	13	890	23	34	82	14	21
Nepal	1	460	33	55	22	3	9
TBA level	**11**	**840**	**24**	**36**	**75**	**12**	**19**

Transboundary Aquifers Information Sheet

AS79 – South of outer Himalayas 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)
India	110	140	400	Aquifer mostly confined, but some parts unconfined	sediment – sand			1800
Nepal								
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 aquifer is a multiple-layered hydraulically connected system, containing 3 layers within India, that is mostly confined, but some parts are unconfined. The average depth to the water table is 110 m, and the average depth to the top of the aquifer is 140 m while the average thickness of the aquifer system is 400 m within India.

Hydrogeological aspects
The predominant aquifer lithology is sediment – sand and data is not available for much of the aquifer hydraulics. The average transmissivity value within India 1800 m^2/d. The total groundwater volume within the system in India is 3576 km^3. The average recharge into the system within India is 66.4 Mm^3/yr and the aerial extent of the major recharge area is 241 000km^2. The annual amount of groundwater depletion is 0.7 km^3/yr that is probably due to over-pumping.

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 within India.

Environmental aspects
Within India around 10 % of the aquifer area is unsuitable for human consumption within the superficial layers. This is mainly due to elevated amounts of natural salinity, Fluoride, and Nitrates. Within India a significant amount of anthropogenic groundwater pollution within the superficial layers has occurred and this amounts to 35 % of the aquifer within the country. The main causes are through municipalities, industrial waste disposal, and through agricultural practices. This produces elevated volumes of salinisation, and heavy metals. Around 17 % of the aquifer within India is characterised by shallow groundwater whereas 36 % is covered with groundwater dependent ecosystems.

Socio-economic aspects
A total of 39.58 Mm^3 of water was abstracted from the system during 2010 within India. The total amount of fresh water that was abstracted over the aquifer area within India for the same year 71.34 Mm^3.

AS79 – South of outer Himalayas Aquifer

Legal and Institutional aspects

Currently there is no Transboundary Agreement and nationally there is no regulating body or Act to regulate groundwater within Nepal. No further information was available with regard to the legal and institutional aspects.

Priority Issues and Hotspots

Over-exploitation of groundwater for agriculture, domestic and industrial uses in the long run is problematic. Furthermore, Arsenic contamination in the shallow aquifer of some selected districts is of concern. The international impact on groundwater abstraction/ degradation has in the past been neglected against a focus on national water resources planning. However, increased stresses on Regional water resources will require shared aquifer management as a component of long-term planning. Water logging & inland salinity, groundwater pollution (arsenic in some selected areas and natural source) and over-exploitation are causes for concern.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Sangam Shresta	Asian Institute of Technology	Thailand	sangamshrestha@gmail.com	Regional coordinator
Devinder Kumar Chadha	Global Hydrogeological Solutions	India	devinderchadha27@gmail.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.

Only 1 of the 2 TBA countries has provided information. Information was adequate to describe the aquifer in general terms. Some quantitative information was also available, but this was not enough to calculate all of the indicators with.

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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AS79 – South of outer Himalayas Aquifer

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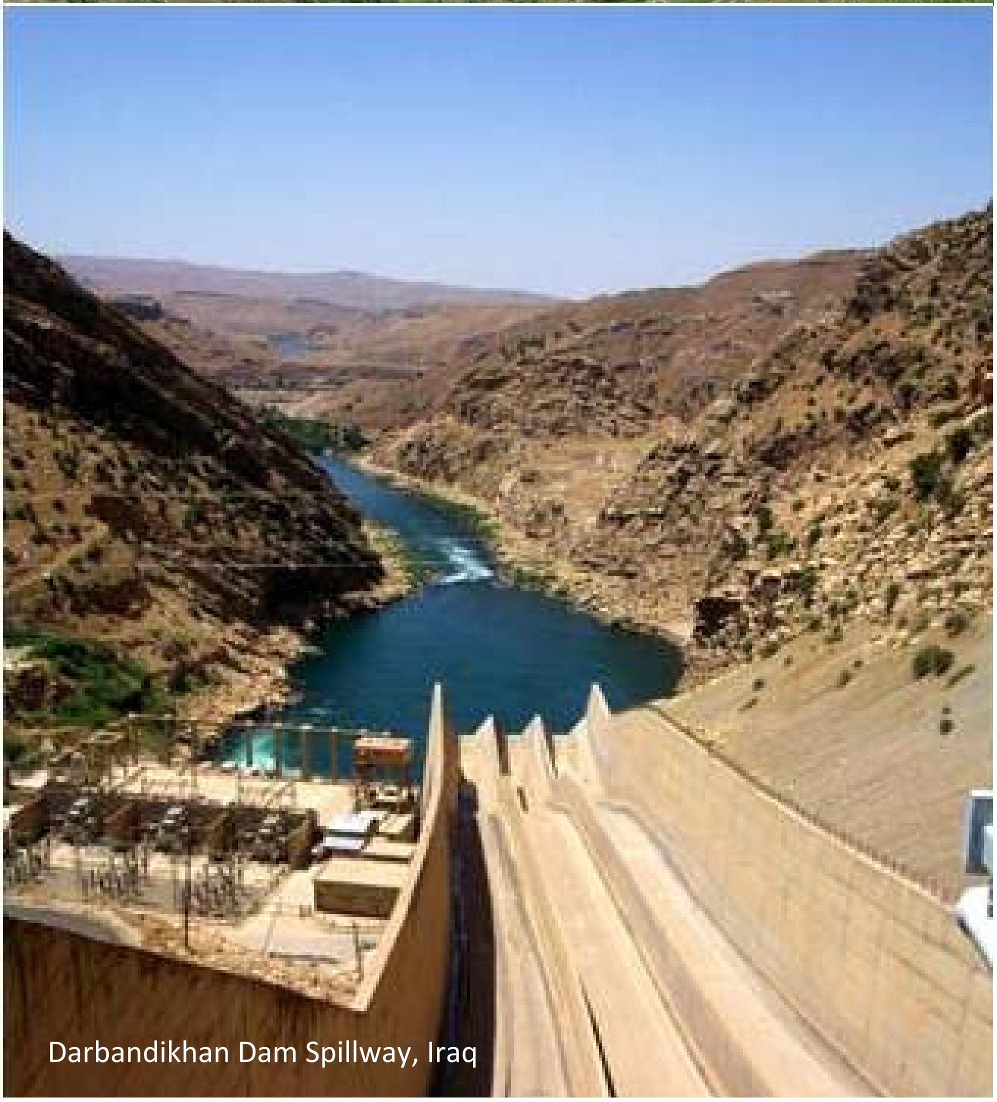
- All other data: TWAP Groundwater (2015).

Version: May 2017

1. Aras Su Qovsaginin Su Anbari
2. Caspian Sea
3. Lake Darbandikhan
4. Lake Mangla
5. Lake Sistan

Lake Darbandikhan

Adam Jones, CC BY-SA 2.0



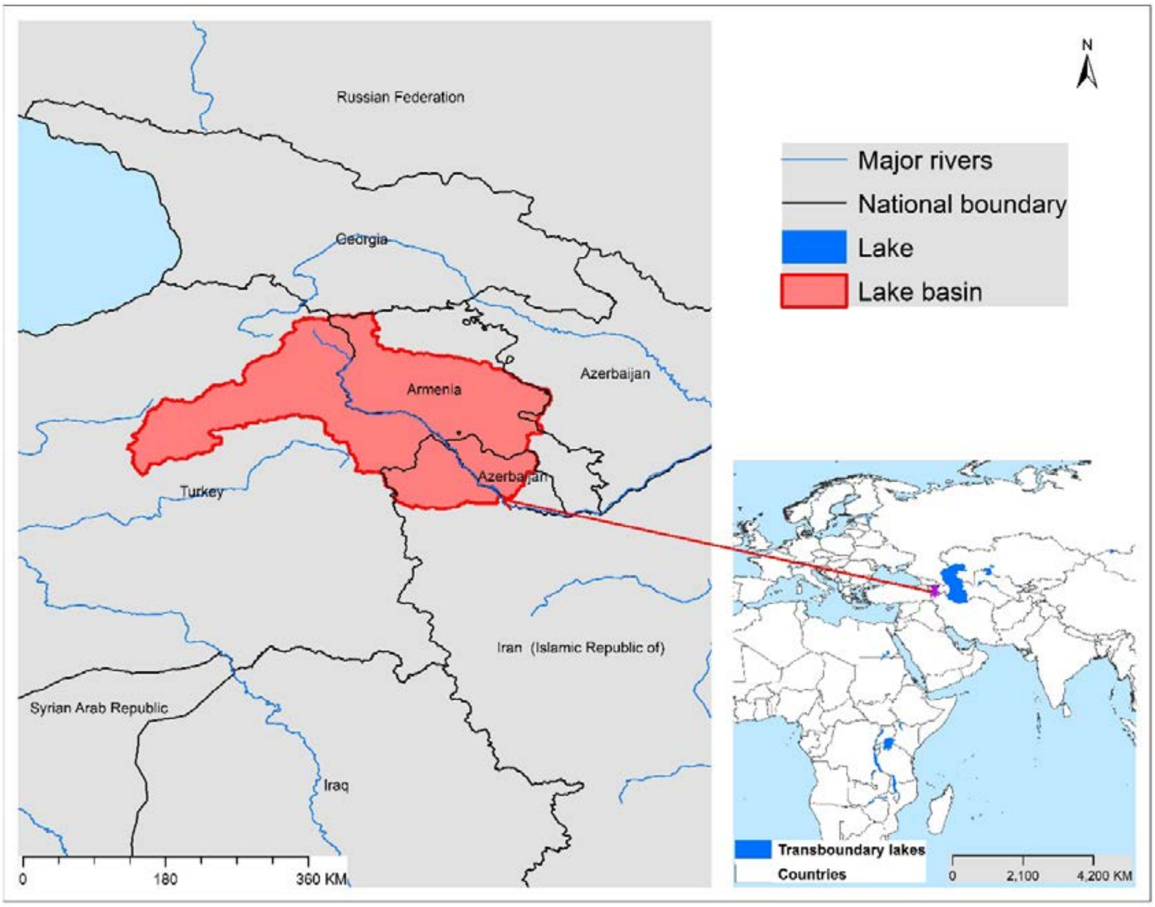
Darbandikhan Dam Spillway, Iraq

U.S. Army Corps of Engineers

Aras Su Qovsaginin Su Anbari

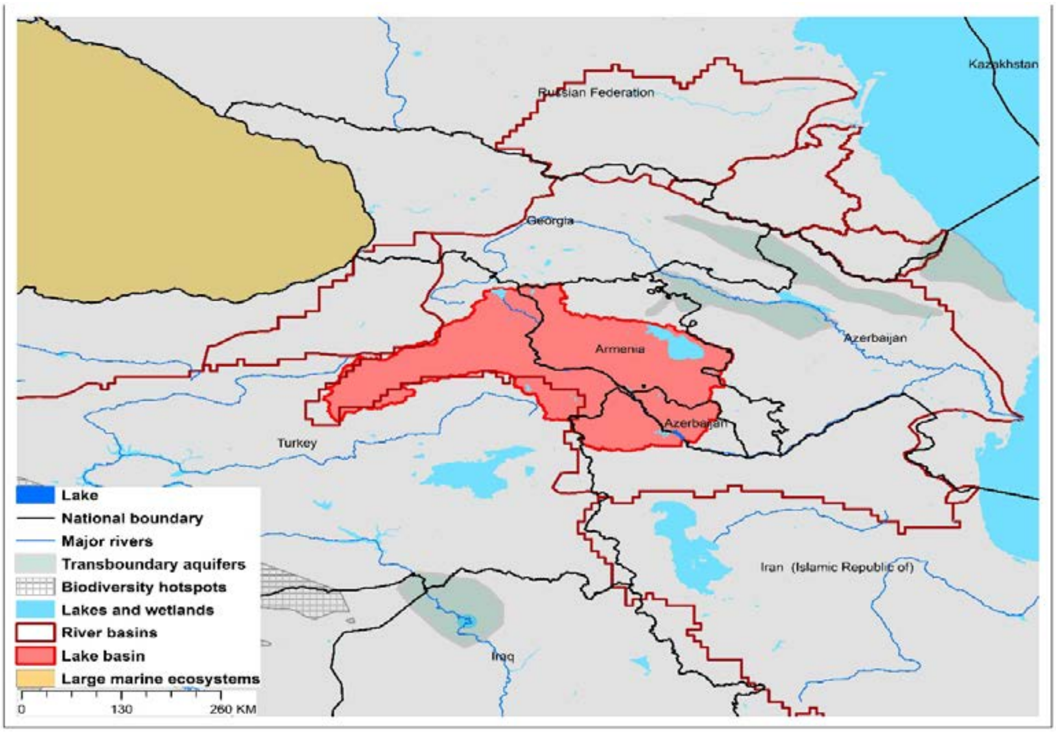
Geographic Information

Aras Su Qovsaginin Su Anbari is a reservoir on the Aras River constructed for hydropower production, being shared by the Azerbaijan Republic and the Islamic Republic of Iran. Since its opening, the reservoir also has provided irrigation water for more than 400,000 ha of arable land in the two countries. At its normal water elevation, the reservoir capacity is 1.35 km^3. The reservoir has a long history of bilateral discussions between Iran and Azerbaijan regarding its operation and management. There is little information, however, regarding the need for GEF-catalyzed management interventions for any transboundary environmental issues.

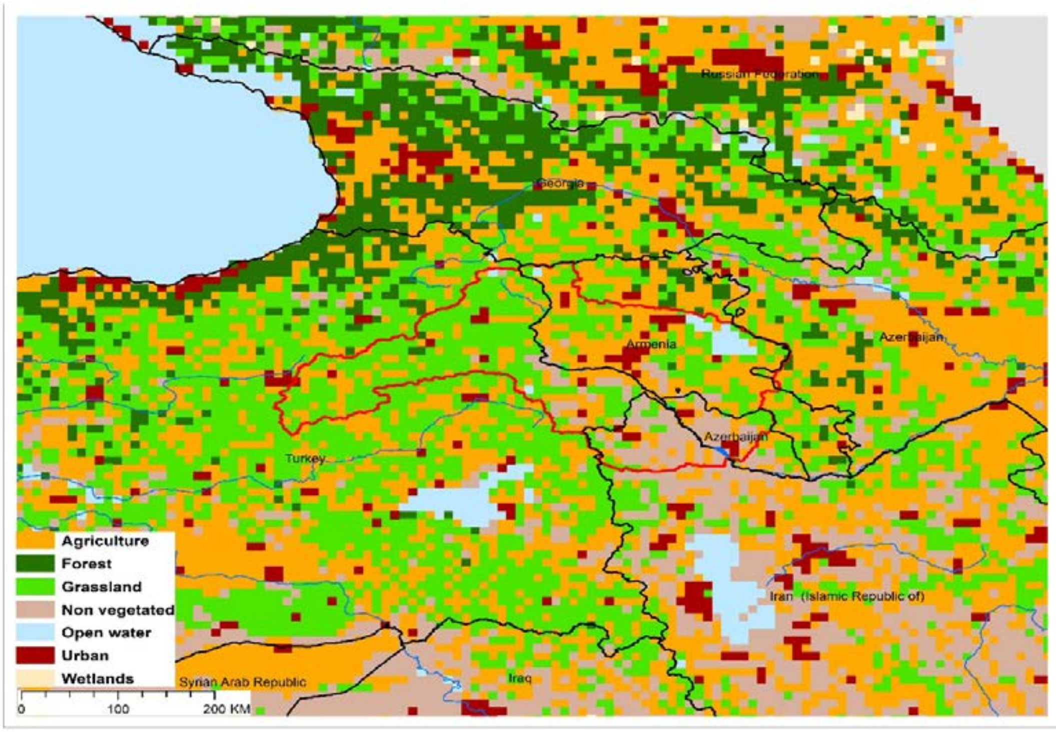


TWAP Regional Designation	Northern Africa & Western Asia; Southern Asia		**Lake Basin Population (2010)**	3,924,400
River Basin	Kura-Arkas		**Lake Basin Population Density (2010; # km^{-2})**	52.3
Riparian Countries	Azerbaijan, Islamic Republic of Iran		**Average Basin Precipitation (mm yr^{-1})**	460.6
Basin Area (km^2)	49,434		**Shoreline Length (km)**	66.7
Lake Area (km^2)	52.1		**Human Development Index (HDI)**	0.73
Lake Area:Lake Basin Ratio	0.001		**International Treaties/Agreements Identifying Lake**	Yes

Aras Su Qovsaginin Su Anbari Basin Characteristics



(a) Aras Su Qovsaginin Su Anbari basin and associated transboundary water systems



(b) Aras Su Qovsaginin Su Anbari basin land use

Aras Su Qovsaginin Su Anbari 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 Aras Su Qovsaginin Su Anbari 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 Aras Su Qovsaginin Su Anbari 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 Aras Su Qovsaginin Su Anbari 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. Aras Su Qovsaginin Su Anbari 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
0.89	15		0.47	45		0.73	36

It is emphasized that the Aras Su Qovsaginin Su Anbari 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 Aras Su Qovsaginin Su Anbari indicates a moderately high threat rank compared to other priority transboundary lakes.

The Reverse Biodiversity (RvBD) for Aras Su Qovsaginin Su Anbari, which is meant to describe its biodiversity sensitivity to basin-derived degradation, places the lake in a 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 Aras Su Qovsaginin Su Anbari basin in a moderately low threat rank in regard to its health, educational and economic status.

Table 2. Aras Su Qovsaginin Su Anbari 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 figures; 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
15	35	45		59	33		50	26		94	34

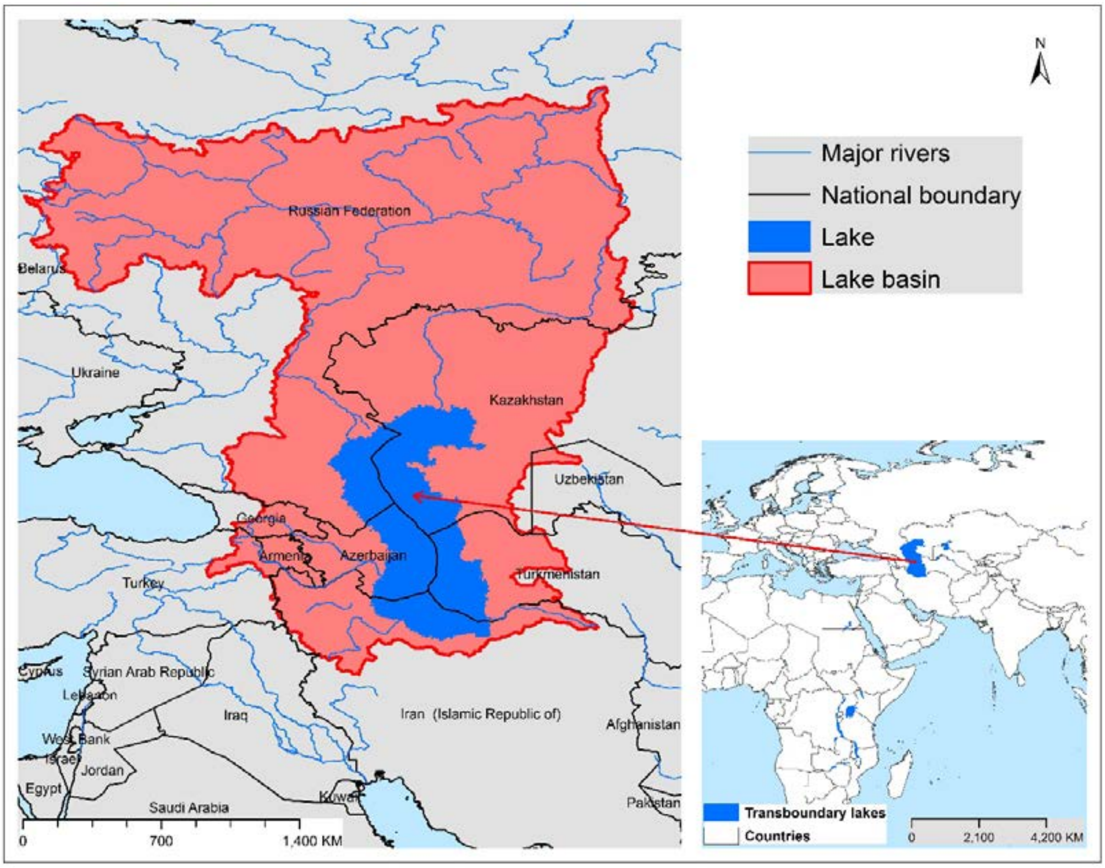
When multiple ranking criteria are considered together in the threat rank calculations, the Adj-HWS and HDI scores place Aras Su Qovsaginin Su Anbari in the upper half of the threat ranks. The relative threat decreases when the Adj-HWS and RvBD threats are considered together. Considering all three ranking criteria together, Aras Su Qovsaginin Su Anbari exhibits an overall moderately high threat ranking.

Interactions between the ranking parameters for Aras Su Qovsaginin Su Anbari indicate differing sensitivity to basin-derived stresses. Identifying potential management interventions needs for Aras Su Qovsaginin Su Anbari 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 Aras Su Qovsaginin Su Anbari basin? Accurate answers to such questions for Aras Su Qovsaginin Su Anbari, 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

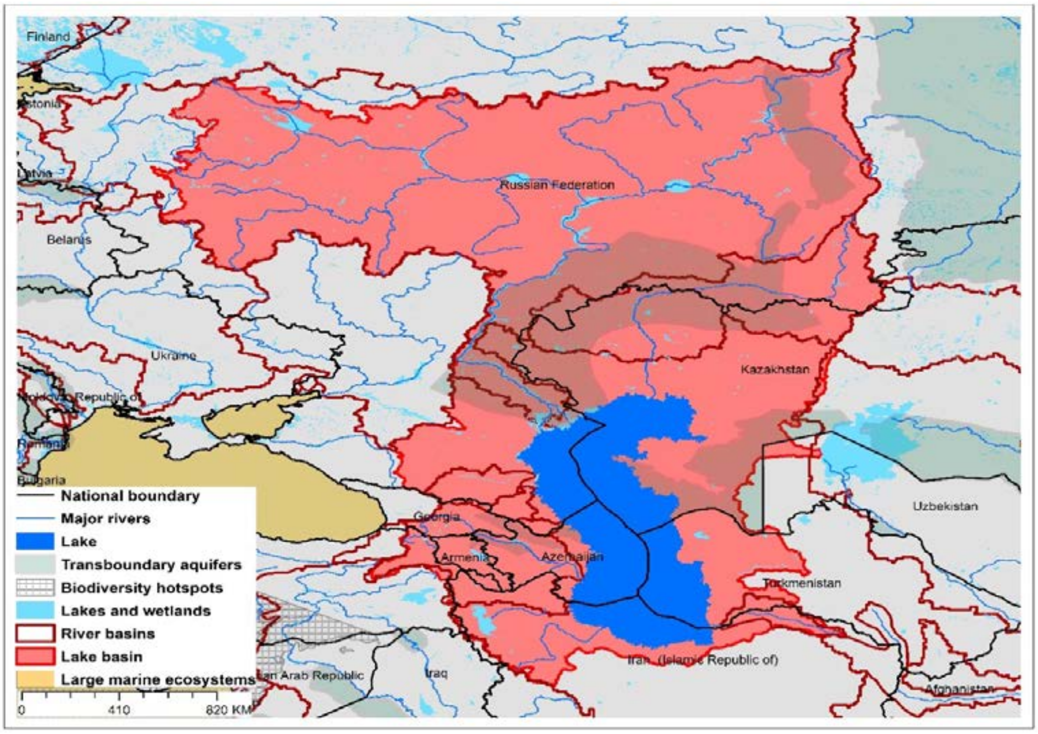
Geographic Information

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.

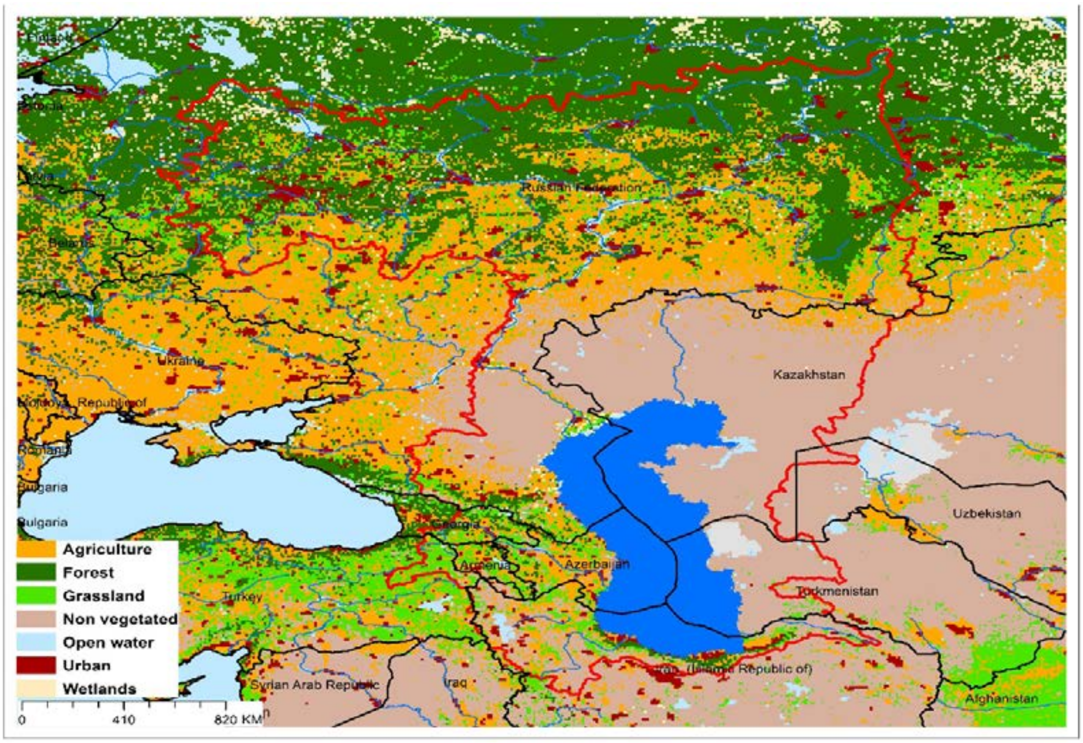


TWAP Regional Designation	Northern Africa & Western Asia; Eastern & Central Asia; Southern Asia; Eastern Europe	**Lake Basin Population (2010)**	105,000,000
River Basin	Caspian (endorheic)	**Lake Basin Population Density (2010; # km^{-2})**	20.1
Riparian Countries	Azerbaijan, Iran, Kazakhstan, Russia	**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

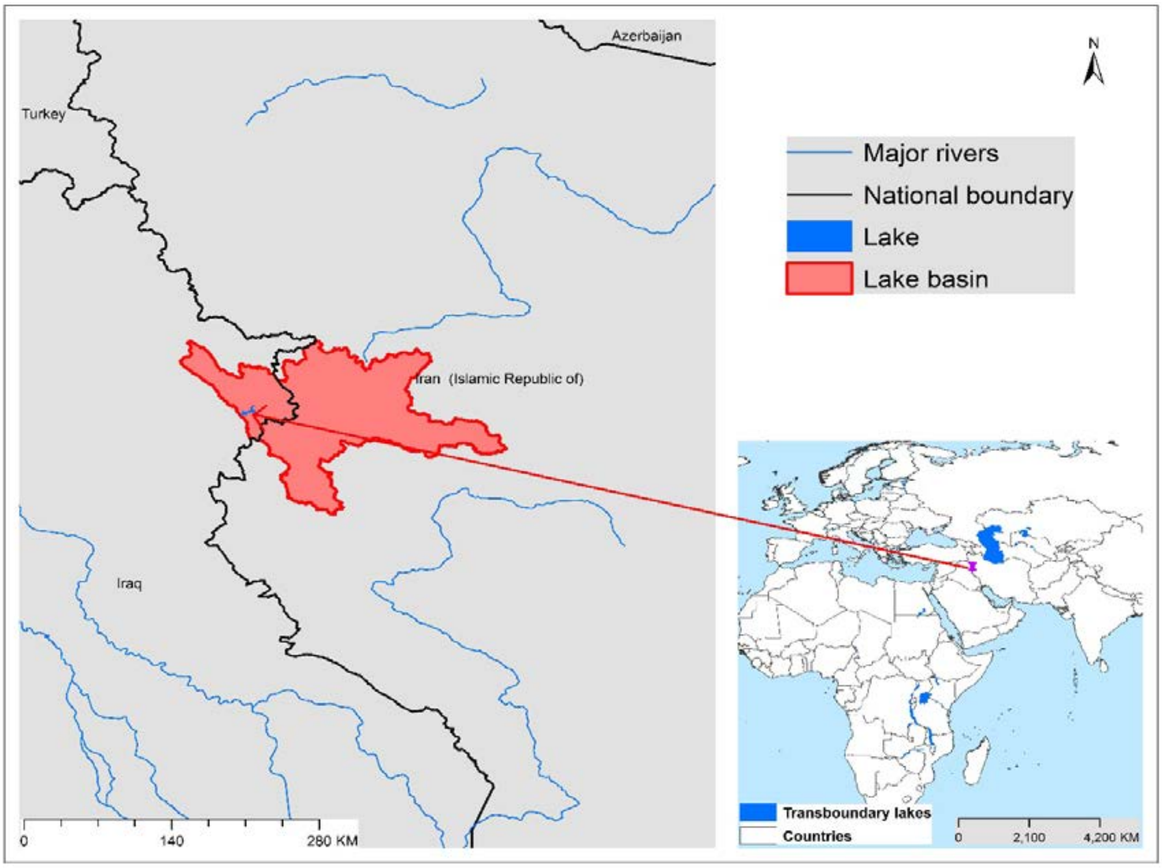
When multiple ranking criteria are considered together in the threat rank calculations, the Adj-HWS and HDI scores considered together place Caspian Sea in the lower quarter of the threat ranks. The relative threat is somewhat increased when the Adj-HWS and RvBD threats are considered together. Considering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

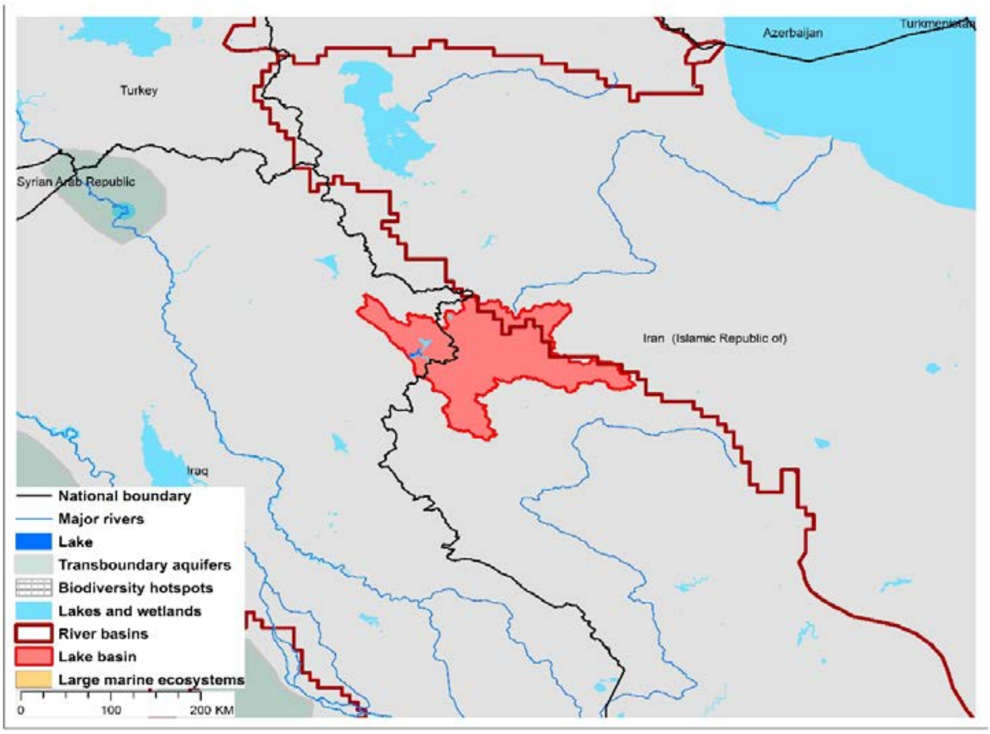
Geographic Information

Lake Darbandikhan is a reservoir constructed for irrigation, flood control, hydropower production and recreation. Its dam has undergone several repairs since its construction between 1956 - 1961, attributed to poor construction and neglect. Several slope failures have occurred since its construction. The dam spillway and power station suffered damage during the Iran-Iraq war, with the power station recently rehabilitated. The area as a whole supports significant bird life, as well as recreational use and a fishery. Nevertheless, the lake is reported to be facing water quality degradation resulting in occasional fish kills. It is not clear that the riparian countries have any direct interest in addressing these issues through an international intervention facilitated by the GEF. Any consideration of a GEF-catalyzed management intervention should be preceded by an assessment of the current scientific and political situation.

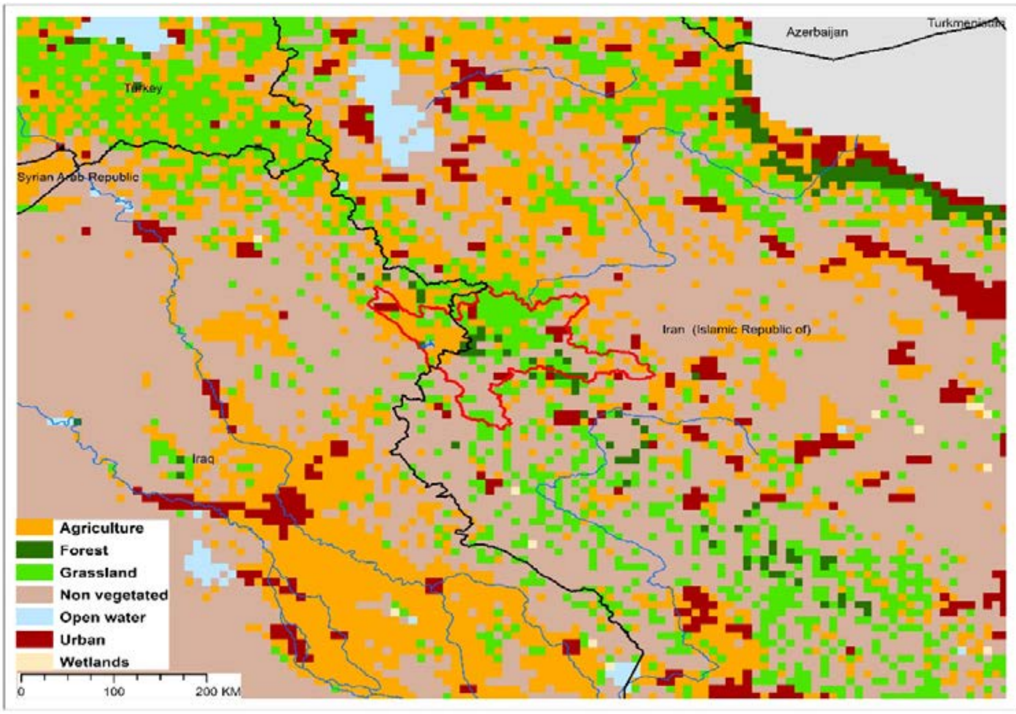


TWAP Regional Designation	Northern Africa & Western Asia; Southern Asia	**Lake Basin Population (2010)**	1,822,575
River Basin	Tigris/Euphrates	**Lake Basin Population Density (2010; # km^{-2})**	76.6
Riparian Countries	Iran, Iraq	**Average Basin Precipitation (mm yr^{-1})**	610.0
Basin Area (km^2)	15,725	**Shoreline Length (km)**	94.0
Lake Area (km^2)	114.3	**Human Development Index (HDI)**	0.68
Lake Area:Lake Basin Ratio	0.002	**International Treaties/Agreements Identifying Lake**	No

Lake Darbandikhan Basin Characteristics



(a) Lake Darbandikhan basin and associated transboundary water systems



(b) Lake Darbandikhan basin land use

Lake Darbandikhan 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 Danbandikhan 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 Danbandikhan 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 Danbandikhan 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 Darbandikhan 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
0.87	18		0.46	46		0.68	30

It is emphasized that the Lake Danbandikhan 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 Danbandikhan indicates a moderately high threat rank compared to other priority transboundary lakes.

The Reverse Biodiversity (RvBD) for Lake Danbandikhan, which is meant to describe its biodiversity sensitivity to basin-derived degradation, places the lake in a 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 Danbandikhan basin in a medium threat rank in regard to its health, educational and economic conditions.

Table 2. Lake Darbandikhan 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)

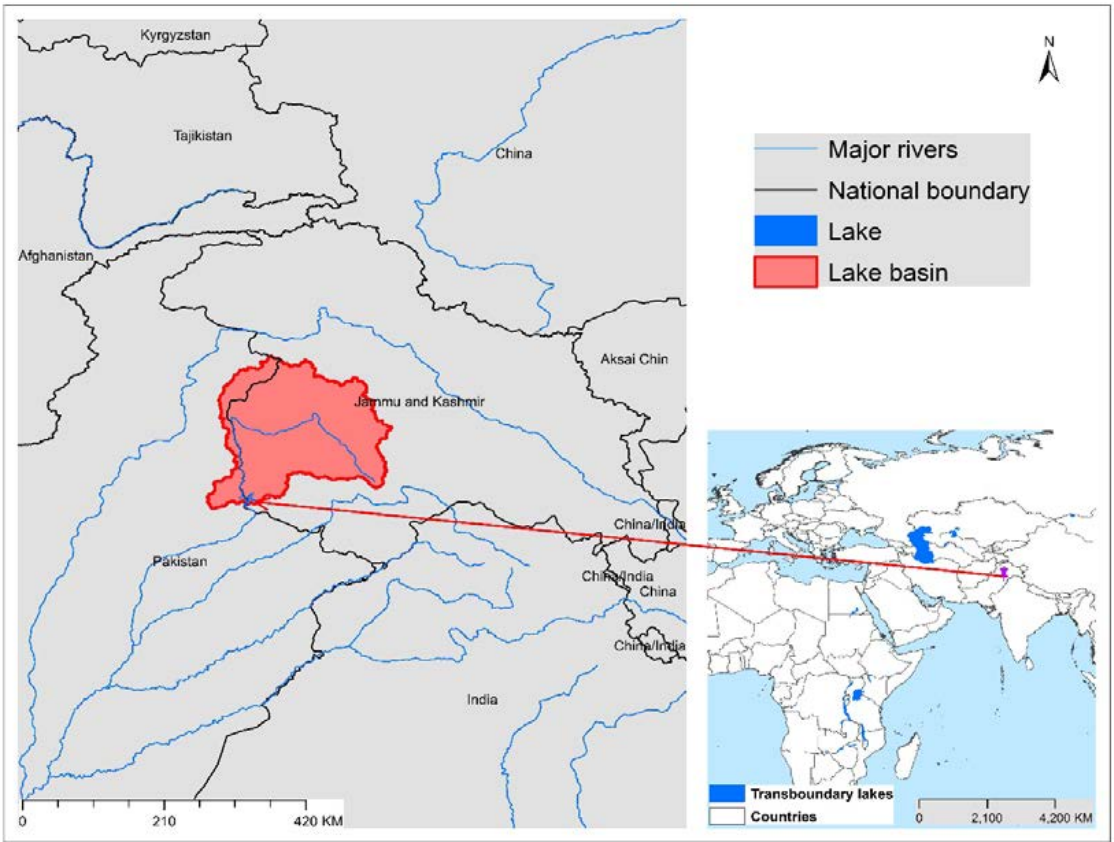
Adj-HWS Rank	HDI Rank	RvBD Rank		Sum Adj-HWS + RvBD	Relative Threat Rank		Sum Adj-HWS + HDI	Relative Threat Rank		Sum Adj-HWS + RvBD + HDI	Overall Threat Rank
17	30	46		63	35		47	23		93	33

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

Interactions between the ranking parameters for Lake Danbandikhan indicate differing sensitivity to basin-derived stresses. Identifying potential management interventions needs for Lake Danbandikhan 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 Danbandikhan basin? Accurate answers to such questions for Lake Danbandikhan, 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.

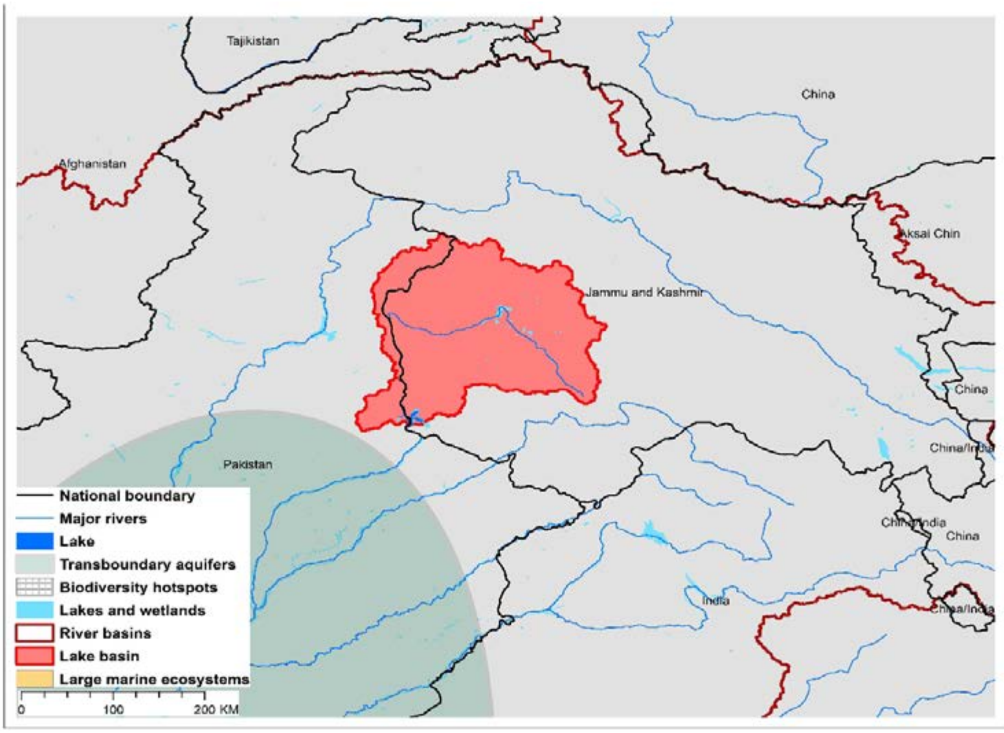
Lake Mangla — Geographic Information

Lake Mangla is a multipurpose reservoir constructed as a result of the Indus Waters Treaty between Pakistan and India. The entire Pakistani irrigation system was previously dependent on unregulated Indus River flows, characterized by low water availability during critical growing periods because of seasonal river flow variations attributed to a lack of storage reservoirs to store surplus water during the monsoon high river discharge periods. The Mangla Dam, the seventh largest in the world, was constructed in part to strengthen this irrigation situation. The Mangla Power Station is the second biggest in Pakistan, with approximately 280 villages being submerged, and more than 100,000 people displaced because of the dam construction. Although the operation and management of Lake Mangla has been the subject of many bilateral discussions between Pakistan and India, there is little information regarding the need for GEF-catalyzed management interventions for any transboundary environmental issues.

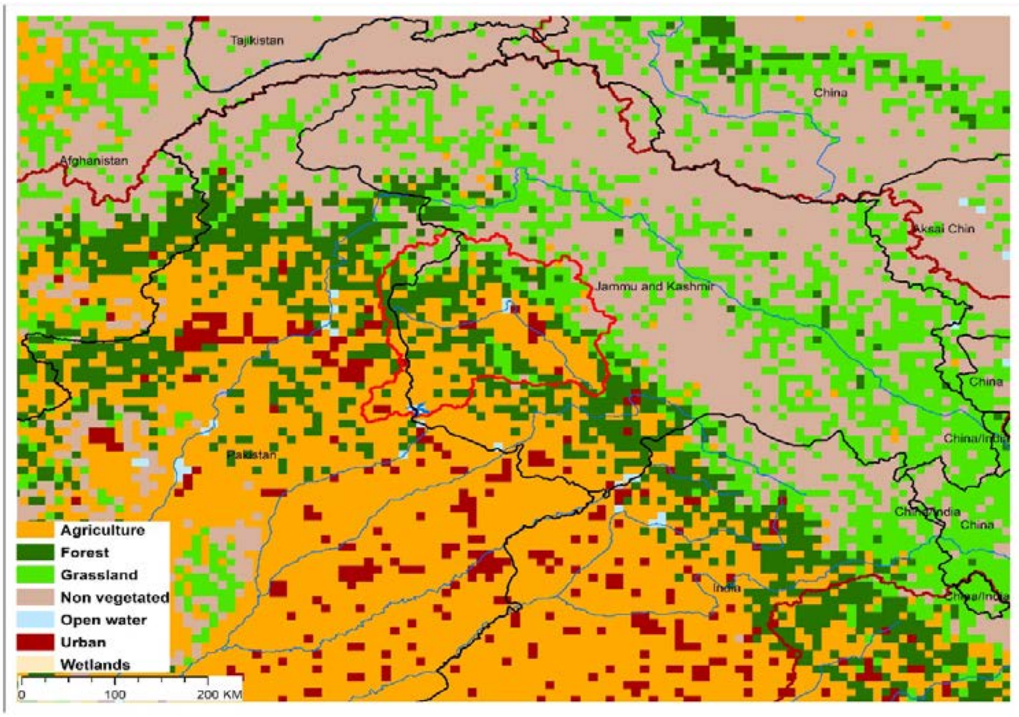


TWAP Regional Designation	Southern Asia	**Lake Basin Population (2010)**	9,832,974
River Basin	Indus	**Lake Basin Population Density (2010; # km^{-2})**	210.2
Riparian Countries	India, Pakistan	**Average Basin Precipitation (mm yr^{-1})**	804.3
Basin Area (km^2)	85.4	**Shoreline Length (km)**	266.0
Lake Area (km^2)	31,114	**Human Development Index (HDI)**	0.54
Lake Area:Lake Basin Ratio	0.002	**International Treaties/Agreements Identifying Lake**	Yes

Lake Mangla Basin Characteristics



(a) Lake Mangla basin and associated transboundary water systems



(b) Lake Mangla basin land use

Lake Mangla 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 Mangla 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 Mangla 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 Mangla 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 Mangla 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	16		0.38	52		0.54	25

It is emphasized that the Lake Mangla 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 Mangla indicates a moderately high threat rank compared to other priority transboundary lakes.

The Reverse Biodiversity (RvBD) for Lake Mangla, which is meant to describe its biodiversity sensitivity to basin-derived degradation, places the lake in a 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 Mangla basin in a medium threat rank in regard to its health, educational and economic conditions.

Table 2. Lake Mangla 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
18	25	53		71	39		43	22		96	36

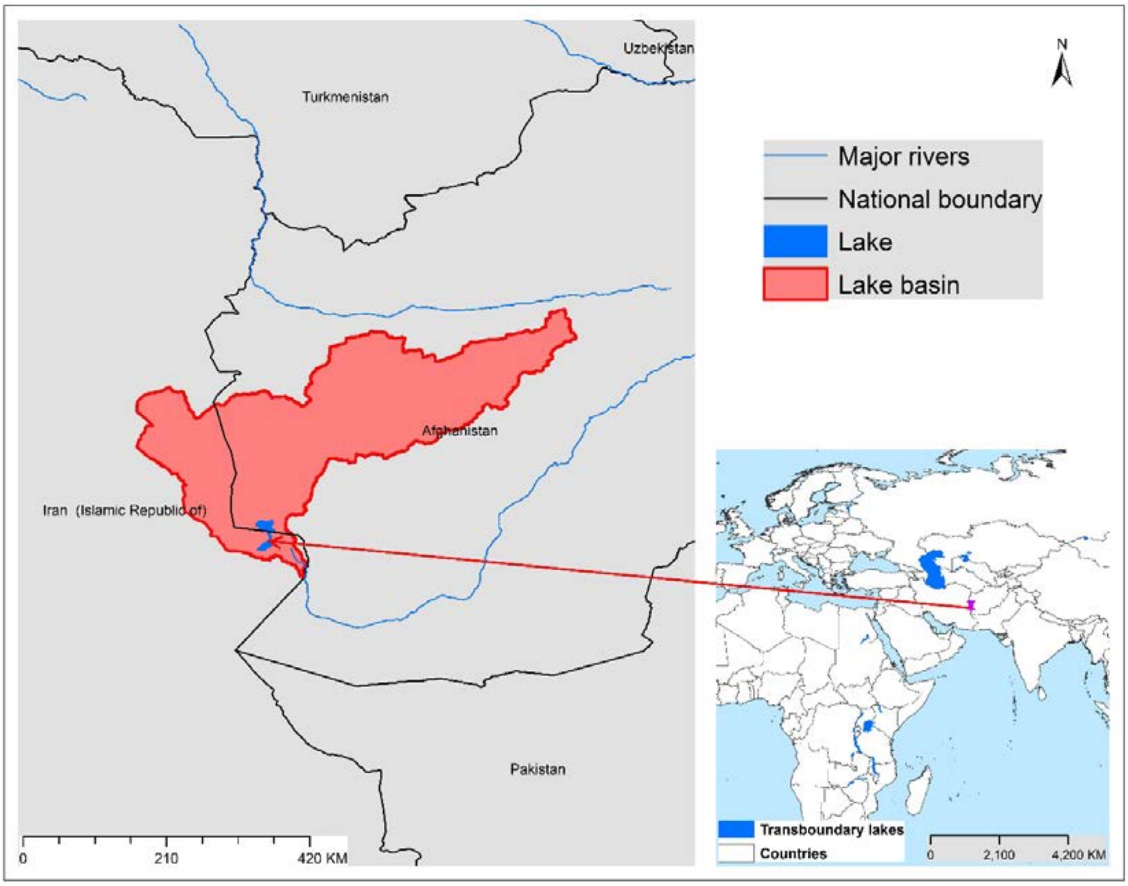
When multiple ranking criteria are considered together in the threat rank calculations, the Adj-HWS and HDI scores considered together place Lake Mangla in the upper quarter of the threat ranks. The relative threat is somewhat reduced when the Adj-HWS and RvBD threats are considered together. Considering all three ranking criteria together, Lake Mangla exhibits a moderately low threat ranking.

Interactions between the ranking parameters for Lake Mangla indicate differing sensitivity to basin-derived stresses. Identifying potential management interventions needs for Lake Mangla 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 Mangla basin? Accurate answers to such questions for Lake Mangla, 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 Sistan

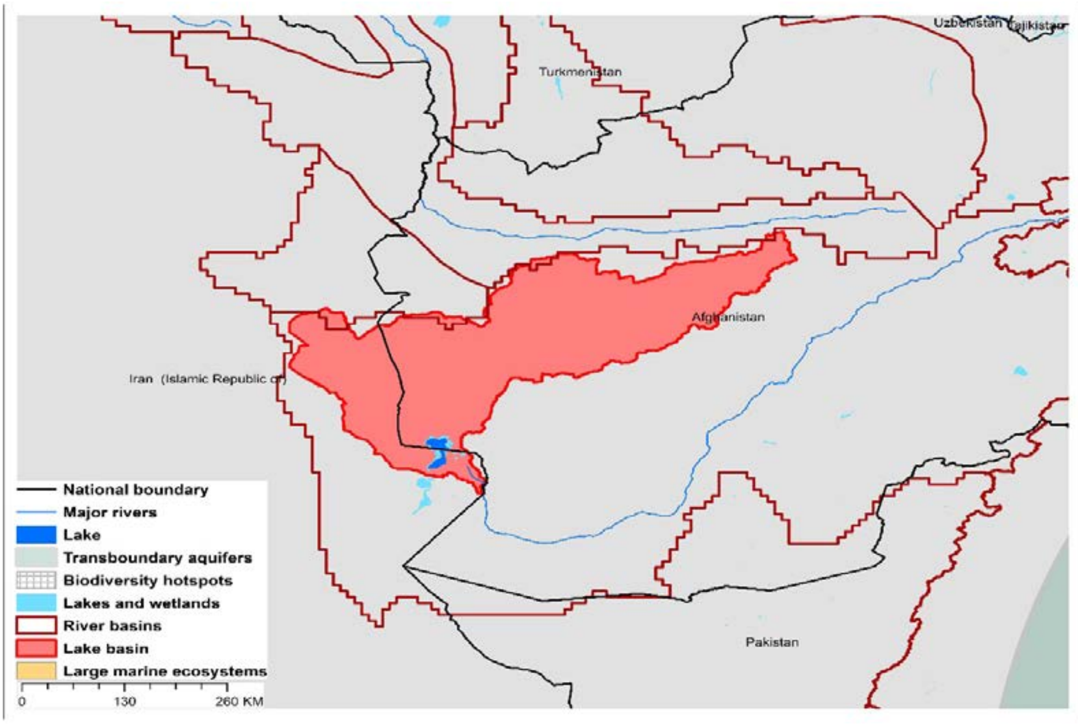
Geographic Information

Lake Sistan is a shallow, marshy lake, part of the extended wetlands of the endorheic Sistan basin occuping a larger border region between eastern Iran and Afghanistan the two countries. It was previously designated as a Ramsar Site. Although the lake is fed primarily from rivers draining into it from Afghanistan, which previously kept the lake level relatively constant, it essentially dried up in Iran in the early-2000s, impacting both wildlife and fisheries, as well as shoreline inhabitants. There have been subsequent efforts to ameliorate the situation with water policy changes, accompanied by subsequent increased rainfall in the region. The lake previously received GEF funding, and any future GEF-catalyzed management interventions should require a review of its GEF status.

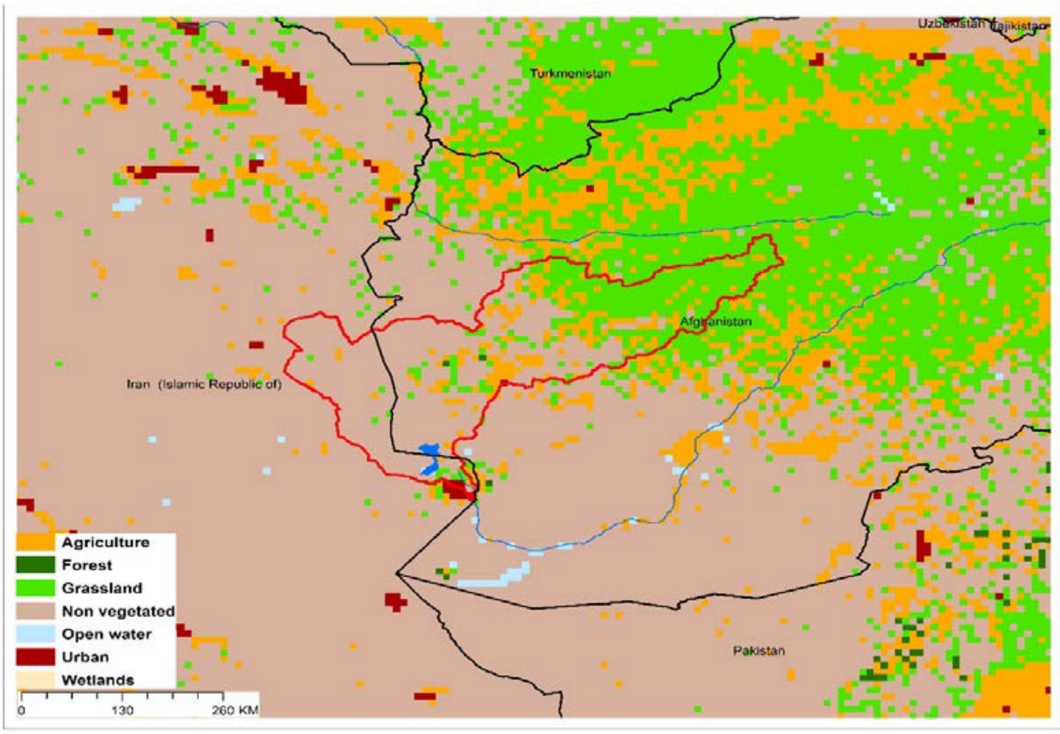


TWAP Regional Designation	Southern Asia	**Lake Basin Population (2010)**	908,284
River Basin	Helmand	**Lake Basin Population Density (2010; # km^{-2})**	8.6
Riparian Countries	Afghanistan, Iran	**Average Basin Precipitation (mm yr^{-1})**	156.8
Basin Area (km^2)	70,951	**Shoreline Length (km)**	302.6
Lake Area (km^2)	488.2	**Human Development Index (HDI)**	0.46
Lake Area:Lake Basin Ratio	0.004	**International Treaties/Agreements Identifying Lake**	No

Lake Sistan Basin Characteristics



(a) Lake Sistan basin and associated transboundary water systems



(b) Lake Sistan basin land use

Lake Sistan 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 Sistan 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 Sistan 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 Sistan 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 Sistan 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
0.98	1		0.62	25		0.46	14

It is emphasized that the Lake Sistan 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 Sistan indicates the highest threat rank compared to other priority transboundary lakes.

The Reverse Biodiversity (RvBD) for Lake Sistan, 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 Lake Sistan basin in a moderately high threat rank in regard to its health, educational and economic conditions.

Table 2. Lake Sistan 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
1	20	25		26	6		21	8		46	14

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

Interactions between the ranking parameters for Lake Sistan indicate differing sensitivity to basin-derived stresses. Identifying potential management interventions needs for Lake Sistan 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 Sistan basin? Accurate answers to such questions for Lake Sistan, 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

Transboundary River Basins of Southern Asia

1. Aral Sea
2. Astara Chay
3. Atrak
4. BahuKalat/ Rudkhanehye
5. Dasht
6. Fenney
7. Ganges-Brahmaputra-Meghna
8. Hamun-i-Mashkel/ Rakshan
9. Hari/ Harirud
10. Helmand
11. Indus
12. Irrawaddy
13. Kaladan
14. Karnaphuli
15. Kowl E Namaksar
16. Kura-Araks
17. Muhuri (aka Little Feni)
18. Murgab
19. Tarim
20. Tigris-Euphrates/ Shatt al Arab

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

Aral Sea Basin

Geography

Total drainage area (km²)	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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Basin Delineation
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Astara Chay Basin

Geography

Total drainage area (km^2)	402
No. of countries in basin	2
BCUs in basin	Azerbaijan (AZE), Iran (Islamic Republic of) (IRN)
Population in basin (people)	71,368
Country at mouth	Azerbaijan
Average rainfall (mm/year)	

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)
ATCY_AZE						
ATCY_IRN						
Total in Basin					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 (%)
ATCY_AZE								
ATCY_IRN								

[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								

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)
ATCY_AZE	0	0.40	23	144.14	1.35			0	7,811.79	0	0.00
ATCY_IRN	0	0.60	48	199.94	1.18	0.00	100.00	0	4,763.30	0	0.00
Total in Basin	0	1.00	71	177.40	1.32	0.00	67.17	0	5,764.08	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
ATCY_AZE					5				3	3	3	3	1	2	1
ATCY_IRN					5				3	5	3	2	1	3	1
River Basin				3	5				3	4	3	2	1	3	1

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
ATCY_AZE									3
ATCY_IRN									3
River Basin					4	4			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] 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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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 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)
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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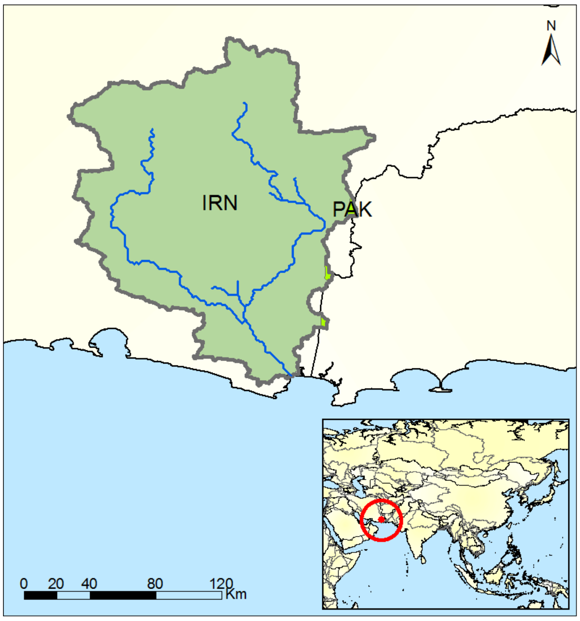
BahuKalat/Rudkhanehye Basin



Geography

Total drainage area (km²)	20,633
No. of countries in basin	2
BCUs in basin	Iran (Islamic Republic of) (IRN), Pakistan (PAK)
Population in basin (people)	234,086
Country at mouth	XXX
Average rainfall (mm/year)	138

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 (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)
RDKH_IRN		78.73				
RDKH_PAK						
Total in Basin	1.62	78.73			0.00	0.00

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 (%)
RDKH_IRN	710.78	645.67	4.17	4.72	5	51.61	3,057.69	
RDKH_PAK								

[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	710.78	645.67	4.17	4.72	4.61	51.61	3,036.39	43.76

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)
RDKH_IRN	21	1.00	232	11.32	1.18			0	4,763.30	1	48.68
RDKH_PAK	0	0.00	2	18.03	1.80			0	1,299.12	0	0.00
Total in Basin	21	1.00	234	11.35	1.33	0.00	0.00	0	4,739.17	1	48.47

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**
RDKH_IRN	4	5	3		5				3	5	3	2	1	3	4
RDKH_PAK					5				3	5	3	3	1	3	2
River Basin	4	5	3	2	5				3	5	3	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
RDKH_IRN	5	5	5	5			1	2	3
RDKH_PAK									4
River Basin	5	5	5	5	2	3	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	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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Dasht Basin

Geography

Total drainage area (km^2)	30,984
No. of countries in basin	2
BCUs in basin	Iran (Islamic Republic of) (IRN), Pakistan (PAK)
Population in basin (people)	629,033
Country at mouth	Pakistan
Average rainfall (mm/year)	109

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)
DSHT_IRN		81.64				
DSHT_PAK		57.49				
Total in Basin	1.91	61.73			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 (%)
DSHT_IRN	198.76	42.31	0.71	145.42	0	10.32	2,833.07	
DSHT_PAK	2,136.76	2,105.75	10.79	0.00	0	20.22	3,823.33	

[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	2,335.53	2,148.06	11.51	145.42	0.00	30.54	3,712.88	122.11

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)
DSHT_IRN	6	0.20	70	11.10	1.18			0	4,763.30	0	0.00
DSHT_PAK	25	0.80	559	22.66	1.80	0.00	100.00	0	1,299.12	0	0.00
Total in Basin	31	1.00	629	20.30	1.62	0.00	88.85	0	1,685.49	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
DSHT_IRN	4	5	2		5				3	5	3	2	1	3	4
DSHT_PAK	5	5	4		5				3	5	3	3	1	3	4
River Basin	5	5	4	2	5				3	5	3	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
DSHT_IRN	5	5	5	5			2	2	3
DSHT_PAK	5	5	5	5			2	3	4
River Basin	5	5	5	5	3	3	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	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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Fenney Basin

Geography

Total drainage area (km^2)	3,028
No. of countries in basin	2
BCUs in basin	Bangladesh (BGD), India (IND)
Population in basin (people)	1,778,226
Country at mouth	Bangladesh
Average rainfall (mm/year)	2,069

Governance

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

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)
FNNY_BGD						
FNNY_IND		1,150.62				
Total in Basin	3.48	1,150.62			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 (%)
FNNY_BGD								
FNNY_IND	229.41	197.58	4.38	0.00	0	27.45	509.40	

[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	229.41	197.58	4.38	0.00	0.00	27.45	129.01	6.58

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)
FNNY_BGD	2	0.50	1,328	879.79	1.12	0.00	100.00	0	829.25	0	0.00
FNNY_IND	2	0.50	450	296.56	1.43	0.00	100.00	0	1,498.87	0	0.00
Total in Basin	3	1.00	1,778	587.29	1.23	0.00	100.00	0	998.84	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
FNNY_BGD					5	2			2	5	2	2	1	3	5
FNNY_IND	1	2	2		5	1	4	3	2	5	2	1	1	3	3
River Basin	1	2	2	4	5	2	4	3	2	5	2	2	1	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
FNNY_BGD									3
FNNY_IND	2	3	2	3			1	2	2
River Basin	2	3	3	3	5	5	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	1				

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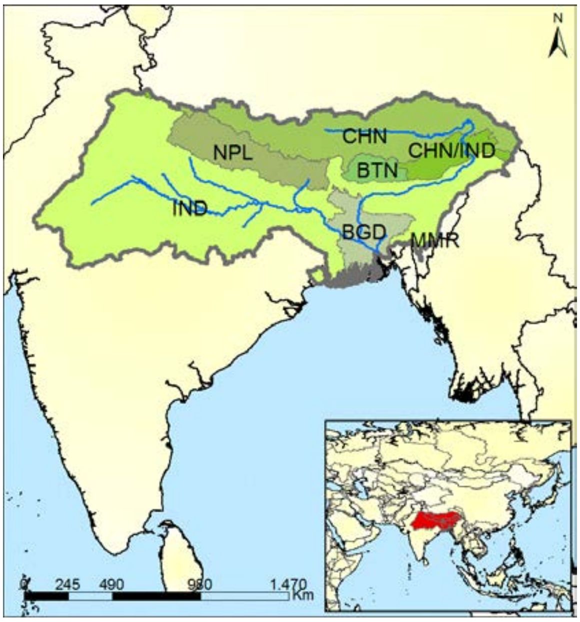
Ganges-Brahmaputra-Meghna Basin



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

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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 (%)
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 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)
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

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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**
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

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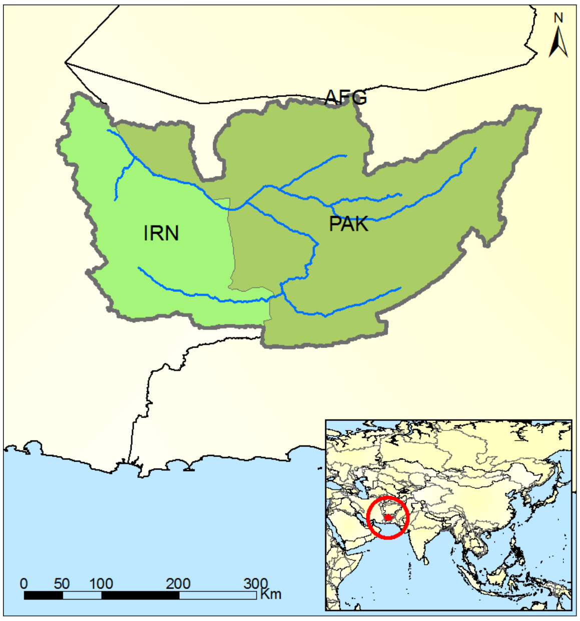
Hamun-i-Mashkel/Rakshan Basin



Geography

Total drainage area (km²)	116,508
No. of countries in basin	3
BCUs in basin	Afghanistan (AFG), Iran (Islamic Republic of) (IRN), Pakistan (PAK)
Population in basin (people)	1,073,458
Country at mouth	XXX
Average rainfall (mm/year)	102

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	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)
HIMR_AFG						
HIMR_IRN		57.37				
HIMR_PAK		50.86				
Total in Basin	6.16	52.89			0.00	0.00

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 (%)
HIMR_AFG								

[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/

HIMR_IRN	530.01	480.07	3.45	0.00	0	46.49	1,075.39	
HIMR_PAK	1,564.17	1,528.09	15.24	0.00	0	20.84	2,694.13	
Total in Basin	2,094.18	2,008.17	18.68	0.00	0.00	67.33	1,950.87	33.98

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)
HIMR_AFG	0	0.00	0	6.83				0	678.35	0	0.00
HIMR_IRN	36	0.31	493	13.52		0.00	100.00	0	4,763.30	0	0.00
HIMR_PAK	80	0.69	581	7.25				0	1,299.12	0	0.00
Total in Basin	117	1.00	1,073	9.21	1.50	0.00	45.91	0	2,889.61	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**
HIMR_AFG					5				4	5	3		1	4	
HIMR_IRN	5	5	3		5				3	5	3	2	1	3	5
HIMR_PAK	4	5	3		5				3	5	3	3	1	3	4
River Basin	5	5	3	2	5				3	5	3	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**
HIMR_AFG									4
HIMR_IRN	5	5	5	5					3
HIMR_PAK	5	5	5	5					4
River Basin	5	5	5	5	2	2			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				

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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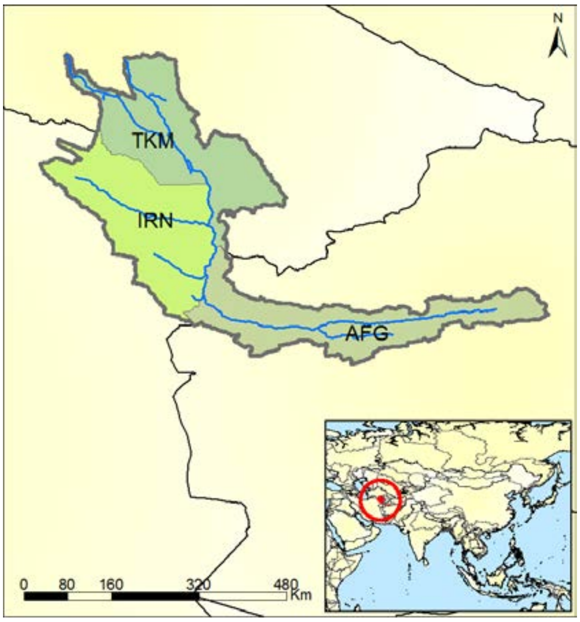
Hari/Harirud Basin



Geography

Total drainage area (km^2)	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 (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)
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 (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 (%)

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
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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

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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
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

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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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Helmand Basin

Geography

Total drainage area (km^2)	403,040
No. of countries in basin	3
BCUs in basin	Afghanistan (AFG), Iran (Islamic Republic of) (IRN), Pakistan (PAK)
Population in basin (people)	12,041,539
Country at mouth	Afghanistan
Average rainfall (mm/year)	185

Governance

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

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	5
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)
HLMD_AFG		86.62			637.97	6.25
HLMD_IRN		47.63			706.53	6.26
HLMD_PAK		63.46				
Total in Basin	31.83	78.97			1,344.50	12.50

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 (%)
HLMD_AFG	32,941.58	32,624.24	27.19	0.17	116	173.87	3,769.47	

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HLMD_IRN	2,538.44	2,366.37	5.44	70.32	10	86.56	2,712.01	
HLMD_PAK	5,250.04	5,116.46	10.10	73.53	0	49.95	2,218.49	
Total in Basin	40,730.06	40,107.07	42.73	144.02	125.86	310.38	3,382.46	127.97

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)
HLMD _AFG	312	0.77	8,739	27.98	2.58	0.00	100.00	1	678.35	2	6.40
HLMD _IRN	47	0.12	936	20.08	1.18	0.00	100.00	2	4,763.30	0	0.00
HLMD _PAK	44	0.11	2,366	53.60	1.80	0.00	100.00	1	1,299.12	0	0.00
Total in Basin	403	1.00	12,042	29.88	2.18	0.00	100.00	4	1,117.87	2	4.96

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**
HLMD_AFG	5	5	5		5	2	3	2	3	5	2		3	3	3
HLMD_IRN	4	5	5		5	3	3	2	3	5	2	2	1	3	4
HLMD_PAK	5	5	5		5				3	5	3	3	1	3	5
River Basin	5	5	5	3	5	2	3	3	2	5	2		2	3	4

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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
HLMD_AFG	5	5	5	5			3	5	3
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River Basin	5	5	5	5	3	2	3	5	3

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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
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Indus Basin

Geography

Total drainage area (km²)	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 (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)
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

[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 (%)
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

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**
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
INDU_PAK	5	5	5	5			2	3	4
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

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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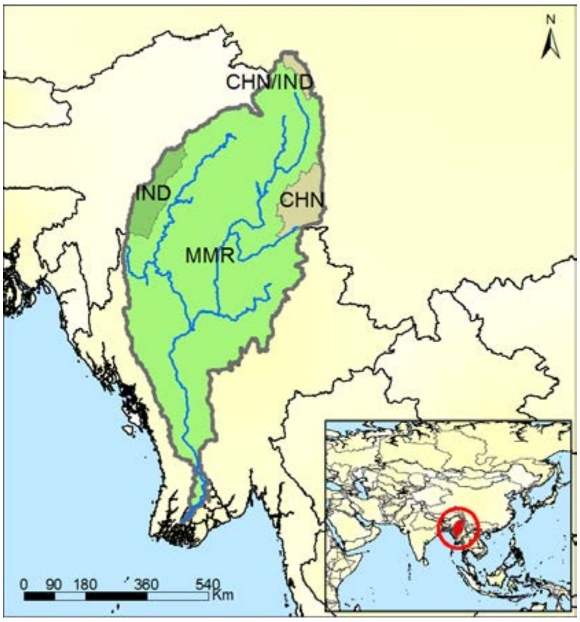
Irrawaddy Basin



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 (%)

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
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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

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**
IRWD_CHN	1	1	2		5	1	4	2	2	5	5	2	1	3	2
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

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

[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/IND									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

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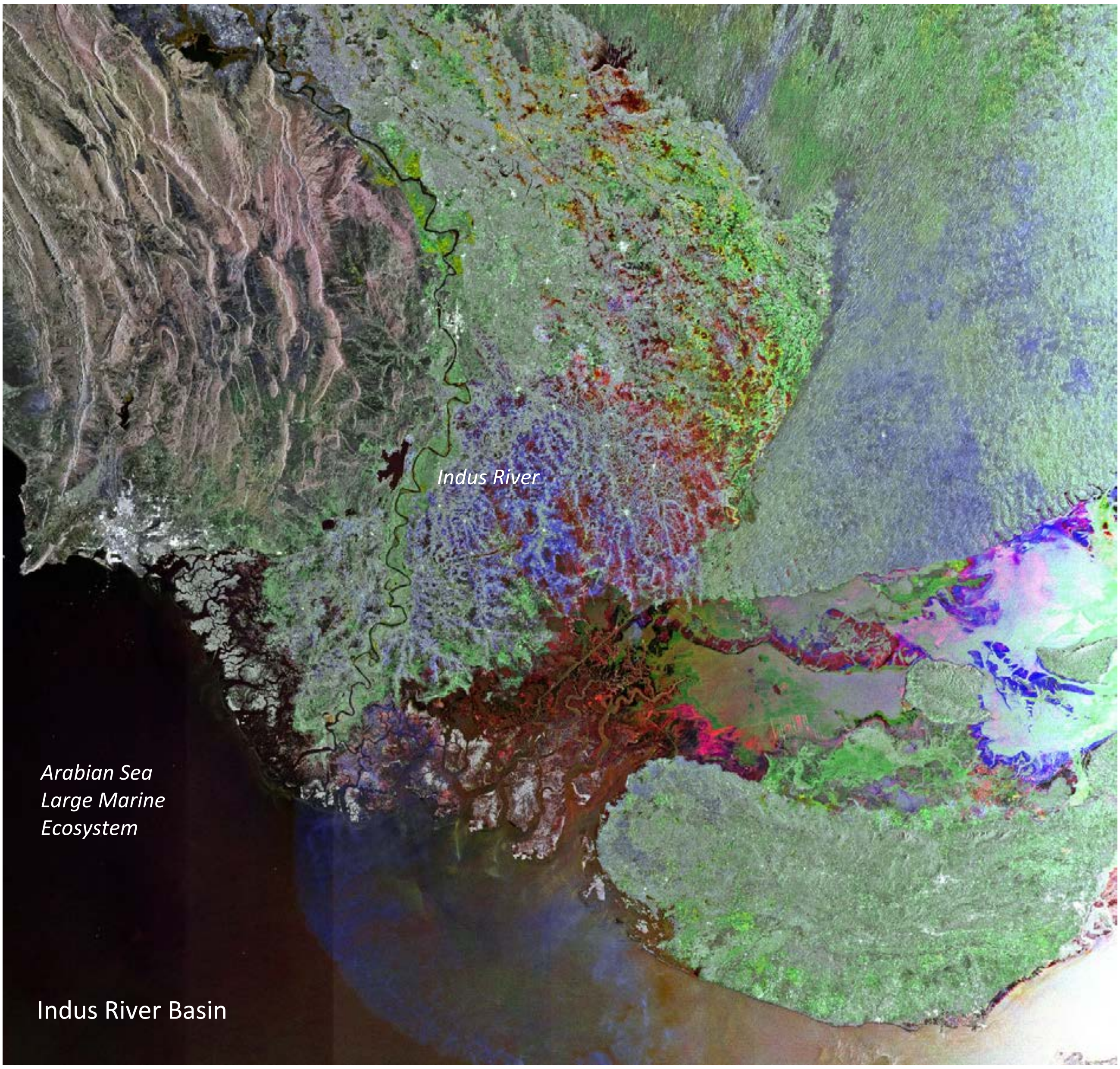

Kaladan Basin

Geography

Total drainage area (km²)	21,391
No. of countries in basin	3
BCUs in basin	Bangladesh (BGD), India (IND), Myanmar (MMR)
Population in basin (people)	628,332
Country at mouth	Myanmar
Average rainfall (mm/year)	3,085

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	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)
KALD_BGD						
KALD_IND		2,260.02				
KALD_MMR		2,114.98				
Total in Basin	46.27	2,163.03			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 (%)
KALD_BGD								

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KALD_IND	49.80	21.11	1.47	11.06	0	16.17	145.43	
KALD_MMR	33.75	9.21	5.06	0.00	2	17.55	118.16	
Total in Basin	83.55	30.31	6.52	11.06	1.93	33.72	132.96	0.18

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)
KALD_BGD	0	0.00	0	22.81				0	829.25	0	0.00
KALD_IND	8	0.38	342	41.82	1.43	0.00	100.00	0	1,498.87	0	0.00
KALD_MMR	13	0.62	286	21.65	0.70			0	0.00	0	0.00
Total in Basin	21	1.00	628	29.37	1.07	0.00	54.50	0	817.22	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**
KALD_BGD					5				1	5	3	2	1	3	1
KALD_IND	1	1	2		5		3	3	1	5	3	1	1	3	2
KALD_MMR	1	1	2		5	1	2	3	1	5	3	4	1	3	3
River Basin	1	1	2	3	5	1	2	3	1	5	3	3	1	2	2

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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
KALD_BGD									4
KALD_IND	2	3	1	1			1	2	3
KALD_MMR	2	3	1	1			1	1	3
River Basin	2	3	1	1	3	4	1	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	1				

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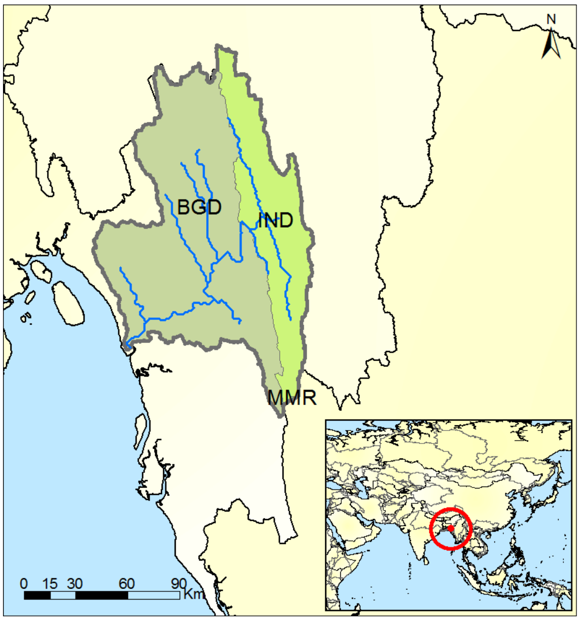
Karnaphuli Basin



Geography

Total drainage area (km^2)	13,923
No. of countries in basin	3
BCUs in basin	Bangladesh (BGD), India (IND), Myanmar (MMR)
Population in basin (people)	6,233,894
Country at mouth	Bangladesh
Average rainfall (mm/year)	2,816

Governance

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

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)
KNFL_BGD		1,611.92			490.80	13.80
KNFL_IND						
KNFL_MMR						
Total in Basin	22.44	1,611.92			490.80	13.80

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 (%)
KNFL_BGD	2,936.50	2,393.20	17.11	241.52	62	222.90	481.62	

[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/

KNFL_IND								
KNFL_MMR								
Total in Basin	2,936.50	2,393.20	17.11	241.52	61.77	222.90	471.05	13.08

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)
KNFL_BGD	10	0.71	6,097	621.13	1.12	0.00	100.00	1	829.25	1	101.87
KNFL_IND	4	0.29	136	33.30	1.43	0.00	100.00	0	1,498.87	0	0.00
KNFL_MMR	0	0.00	0	32.86	0.70			0	0.00	0	0.00
Total in Basin	14	1.00	6,234	447.73	1.22	0.00	99.99	1	843.83	1	71.82

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**
KNFL_BGD	3	1	2		5	1	3	3	2	5	2	2	1	3	4
KNFL_IND		1			5		3	3	2	5	2	1	1	3	2
KNFL_MMR					5				1	5	3	4	1	3	1
River Basin	4	1	2	2	5	1	3	3	2	5	2	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**
KNFL_BGD	4	4	1	2			2	2	3
KNFL_IND			1	1			1	2	2
KNFL_MMR									3
River Basin	4	5	1	1	4	4	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	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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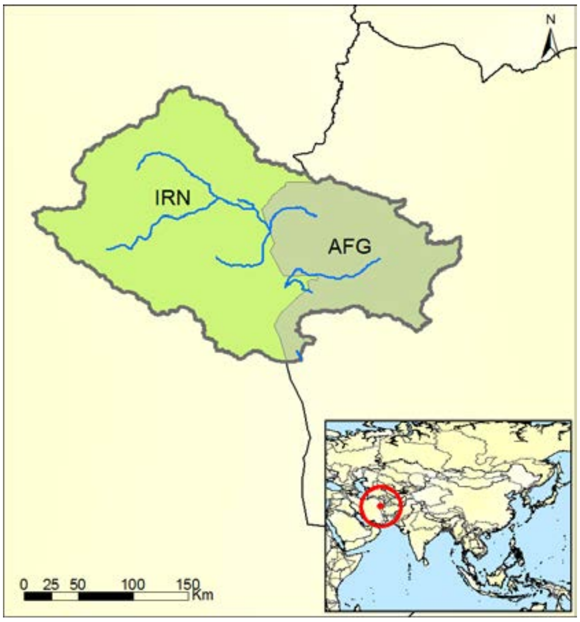
Kowl E Namaksar Basin



Geography

Total drainage area (km^2)	42,272
No. of countries in basin	2
BCUs in basin	Afghanistan (AFG), Iran (Islamic Republic of) (IRN)
Population in basin (people)	469,629
Country at mouth	Afghanistan
Average rainfall (mm/year)	219

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	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)
KOWL_AFG		41.31				
KOWL_IRN		46.43				
Total in Basin	1.89	44.79			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 (%)
KOWL_AFG	638.03	632.70	2.18	0.00	0	3.15	6,270.61	
KOWL_IRN	2,871.43	2,803.10	6.99	5.60	1	54.33	7,805.34	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
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Total in Basin	3,509.46	3,435.80	9.18	5.60	1.41	57.48	7,472.83	185.34

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)
KOWL _AFG	14	0.33	102	7.34	2.58			0	678.35	0	0.00
KOWL _IRN	28	0.67	368	12.95	1.18			0	4,763.30	0	0.00
Total in Basin	42	1.00	470	11.11	1.56	0.00	0.00	0	3,878.26	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
KOWL_AFG	5	5	5		5	5	3	2	3	5	3		1	3	4
KOWL_IRN	5	5	5		5				3	5	3	2	1	3	5
River Basin	5	5	5	2	5	5	3	2	3	5	3		1	3	5

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
KOWL_AFG	5	5	5	5			3	5	4
KOWL_IRN	5	5	5	5			1	2	3
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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Kura-Araks Basin

Geography

Total drainage area (km²)	190,033
No. of countries in basin	6
BCUs in basin	Armenia (ARM), Azerbaijan (AZE), Georgia (GEO), Iran (Islamic Republic of) (IRN), Russian Federation (RUS), Turkey (TUR)
Population in basin (people)	14,462,042
Country at mouth	Azerbaijan
Average rainfall (mm/year)	519

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	6
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)
KURA_ARM		128.01			1,249.90	11.25
KURA_AZE		108.83			604.70	8.26
KURA_GEO		254.40				
KURA_IRN		92.76			106.80	0.70
KURA_RUS						
KURA_TUR		95.16			121.20	2.55
Total in Basin	25.28	133.02			2,082.60	22.76

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 (%)
KURA_ARM	2,634.36	1,814.64	10.29	448.32	108	253.06	696.90	
KURA_AZE	12,076.35	9,493.69	35.09	1,817.57	103	627.13	2,733.08	
KURA_GEO	1,762.26	1,077.83	17.16	162.42	175	329.97	622.44	
KURA_IRN	8,470.13	7,015.19	22.92	860.06	108	464.24	3,531.53	
KURA_RUS								
KURA_TUR	1,335.29	1,242.64	7.16	3.84	11	71.15	1,297.94	
Total in Basin	26,278.39	20,643.98	92.63	3,292.21	504.03	1,745.54	1,817.06	103.95

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)
KURA_ARM	30	0.16	3,780	127.61	0.17	0.36	99.64	2	3,504.77	4	135.03
KURA_AZE	60	0.31	4,419	73.93	1.35	0.00	100.00	1	7,811.79	2	33.46
KURA_GEO	35	0.18	2,831	82.03	-0.57	0.41	99.59	2	3,602.17	4	115.89
KURA_IRN	37	0.20	2,398	64.63	1.18	0.00	100.00	3	4,763.30	2	53.90
KURA_RUS	0	0.00	5	30.52	-0.12			0	14,611.70	0	0.00
KURA_TUR	29	0.15	1,029	35.65	1.31	0.00	100.00	0	10,945.92	1	34.65
Total in Basin	190	1.00	14,462	76.10	0.71	0.17	99.79	8	5,581.58	13	68.41

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**
KURA_ARM	4	4	4		4	1	5	2	3	3	2	5	5	1	2
KURA_AZE	4	5	5		5	2	4	2	3	3	2	3	5	2	2
KURA_GEO	2	3	3		5	1	5	1	3	3	3	4	5	2	3
KURA_IRN	5	5	5		5	1	4	2	3	2	2	2	1	3	3
KURA_RUS					4	3			3	2	3	2	1	2	1
KURA_TUR	5	3	5		3	1	5	2	3	5	3		1	3	5
River Basin	4	5	5	3	5	1	5	2	3	3	2	4	4	3	3

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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**
KURA_ARM	5	5	5	5			1	1	3
KURA_AZE	5	5	5	5			1	1	3
KURA_GEO	3	4	3	3			1	1	4
KURA_IRN	5	5	5	5			1	2	2
KURA_RUS									4
KURA_TUR	5	5	4	4			1	2	3
River Basin	5	5	5	5	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	3				

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Muhuri (aka Little Feni) Basin

Geography

Total drainage area (km²)	3,787
No. of countries in basin	2
BCUs in basin	Bangladesh (BGD), India (IND)
Population in basin (people)	3,312,578
Country at mouth	XXX
Average rainfall (mm/year)	2,567

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 (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)
MHRI_BGD		1,319.94				
MHRI_IND						
Total in Basin	5.00	1,319.94			0.00	0.00

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 (%)
MHRI_BGD	3,011.35	2,717.19	9.12	41.96	66	176.85	1,182.18	
MHRI_IND								

[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	3,011.35	2,717.19	9.12	41.96	66.23	176.85	909.07	60.24

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)
MHRI_BGD	1	0.34	2,547	1,988.29		0.00	100.00	1	829.25	0	0.00
MHRI_IND	3	0.66	765	305.35		0.00	100.00	0	1,498.87	1	398.99
Total in Basin	4	1.00	3,313	874.62	1.23	0.00	100.00	1	983.95	1	264.03

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
MHRI_BGD	2	4	3		5	5	4	3	2	5	3	2	1	3	5
MHRI_IND					5	2			2	5	3	1	1	3	5
River Basin	3	3	3	5	5	4	4	3	2	5	3	2	1	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
MHRI_BGD	3	4	4	4					4
MHRI_IND									3
River Basin	3	4	3	3	5	5			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				

[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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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

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

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 (%)
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 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)
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

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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

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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
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TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
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Tigris-Euphrates/Shatt al Arab Basin

Geography

Total drainage area (km^2)	868,060
No. of countries in basin	6
BCUs in basin	Iran (Islamic Republic of) (IRN), Iraq (IRQ), Jordan (JOR), Saudi Arabia (SAU), Syrian Arab Republic (SYR), Turkey (TUR)
Population in basin (people)	65,437,198
Country at mouth	Iraq
Average rainfall (mm/year)	357

Governance

No. of treaties and agreements[1]	7
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	27
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)
TIGR_IRN		298.74			404.61	2.92
TIGR_IRQ		89.08			5,376.79	131.98
TIGR_JOR		0.40				
TIGR_SAU		23.86				
TIGR_SYR		83.66			638.60	9.39
TIGR_TUR		278.37			1,864.30	28.05
Total in Basin	147.67	170.12			8,284.30	172.34

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 (%)
TIGR_IRN	27,566.02	24,603.83	43.33	636.32	472	1,810.17	2,142.50	
TIGR_IRQ	50,923.51	44,463.97	35.62	4,524.60	347	1,552.22	1,765.88	
TIGR_JOR	1.44	0.00	0.10	0.00	0	1.34	1,085.14	
TIGR_SAU	5.28	0.00	0.39	0.84	0	4.00	142.66	
TIGR_SYR	13,644.50	12,518.08	21.58	311.18	129	664.20	1,155.71	
TIGR_TUR	19,567.23	17,779.30	62.61	310.42	323	1,092.06	1,645.84	
Total in Basin	111,707.97	99,365.18	163.63	5,783.37	1,271.81	5,123.99	1,707.10	75.65

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)
TIGR_IRN	164	0.19	12,866	78.58	1.18	0.00	100.00	12	4,763.30	6	36.64
TIGR_IRQ	398	0.46	28,838	72.54	2.93	0.00	100.00	19	6,669.54	7	17.61
TIGR_JOR	0	0.00	1	5.98	2.94			0	5,214.19	0	0.00
TIGR_SAU	17	0.02	37	2.21	2.65			0	25,851.60	0	0.00
TIGR_SYR	114	0.13	11,806	103.55	1.98	0.00	100.00	5	0.00	1	8.77
TIGR_TUR	176	0.20	11,889	67.63	1.31	0.00	100.00	13	10,945.92	19	108.08
Total in Basin	868	1.00	65,437	75.38	1.97	0.00	99.94	49	5,879.19	33	38.02

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**
TIGR_IRN	4	4	4		5	1	4	4	3	3	2	2	3	3	2
TIGR_IRQ	4	5	5		5	4	5	3	3	2	3	3	5	2	3
TIGR_JOR	5		1		3					4	3	2	1	2	5
TIGR_SAU	4	5	1		4				4	5	3	3	1	2	5
TIGR_SYR	4	5	5		1	2	5	3	3	4	4		4	2	3
TIGR_TUR	3	2	3		3	1	5	4	3	3	3		4	3	2
River Basin	4	5	5	3	4	2	5	4	3	3	3		5	3	2

Indicators

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

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**
TIGR_IRN	5	5	4	4			1	2	3
TIGR_IRQ	5	5	5	5			3	5	4
TIGR_JOR	5	5					3	4	3
TIGR_SAU	5	5	5	5					3
TIGR_SYR	5	5	5	5			2	4	4
TIGR_TUR	5	5	3	4			1	2	4
River Basin	5	5	5	5	3	4	2	4	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	5	4	2	3	5

Indicators

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

Disclaimer

The results and information of factsheet is produced and maintained by the River Basins Component of the GEF Transboundary Water Assessment Programme (GEF TWAP).

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 .

The TWAP River Basins component (TWAP RB) carried out a global comparison of 286 transboundary river basins, in order to enable the prioritisation of funds for basins at risk from a variety of issues, covering water quantity, water quality, ecosystems, governance and socio-economics. It also considered risks to deltas from threats of a transboundary nature, and considered the relative influence of lakes on these river basins. TWAP RB is an indicator–based assessment, allowing for an analysis of basins, based on risks to both societies and ecosystems. It also includes provisional outlook projections to 2030 and 2050 for a limited number of indicators.
Values given in the present fact-sheet represent an approximate guide only and should not replace recent local assessments.

Country Boundaries Under TWAP
TWAP RB assessment uses country delineations provided by FAO GAUL (Global Administrative Unit Layers) (FAO 2014). GAUL uses the International Boundary dataset of the UNCS (UN Cartographic Section) and inland boundaries are same for both datasets. Some differences occur in coastlines,

where FAO GAUL dataset offers more detail.

Disputed areas

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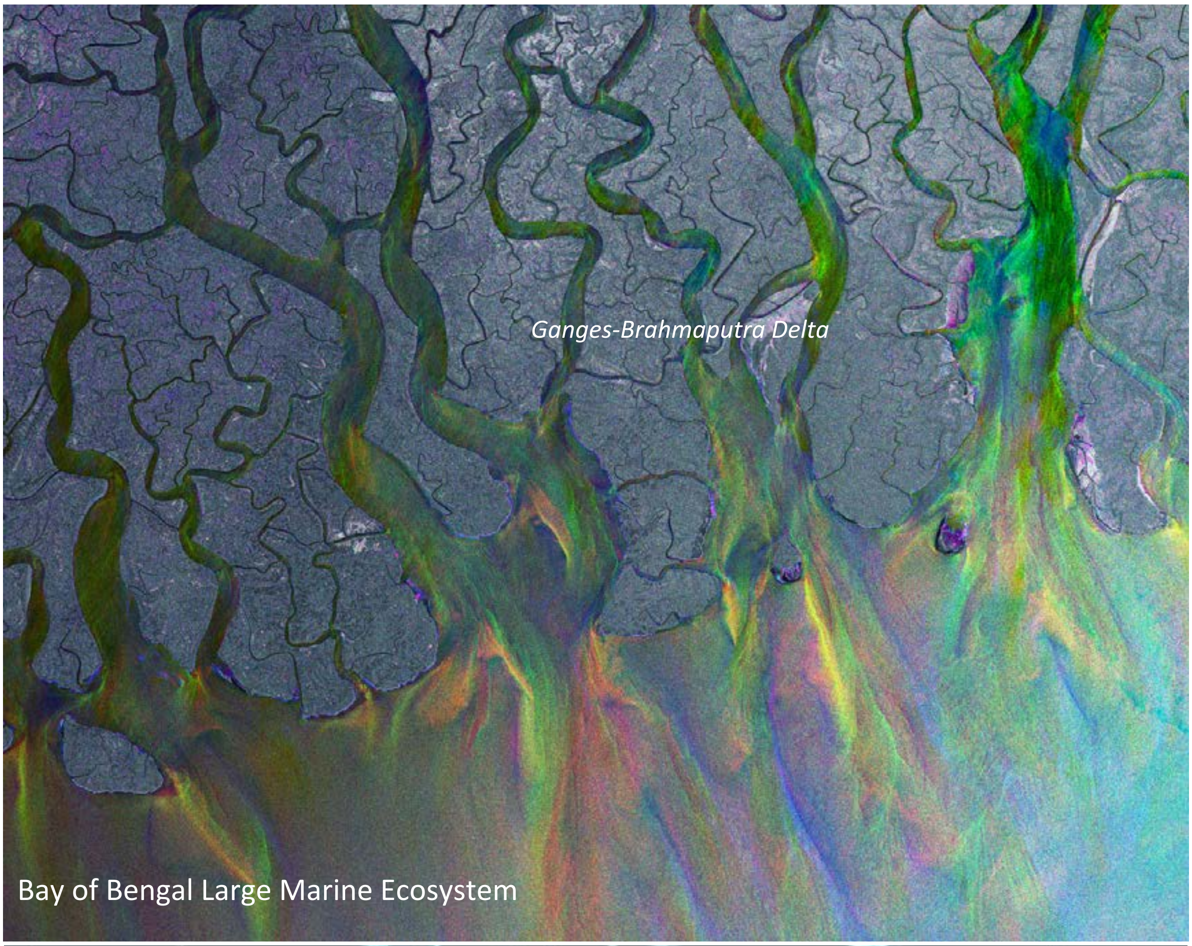
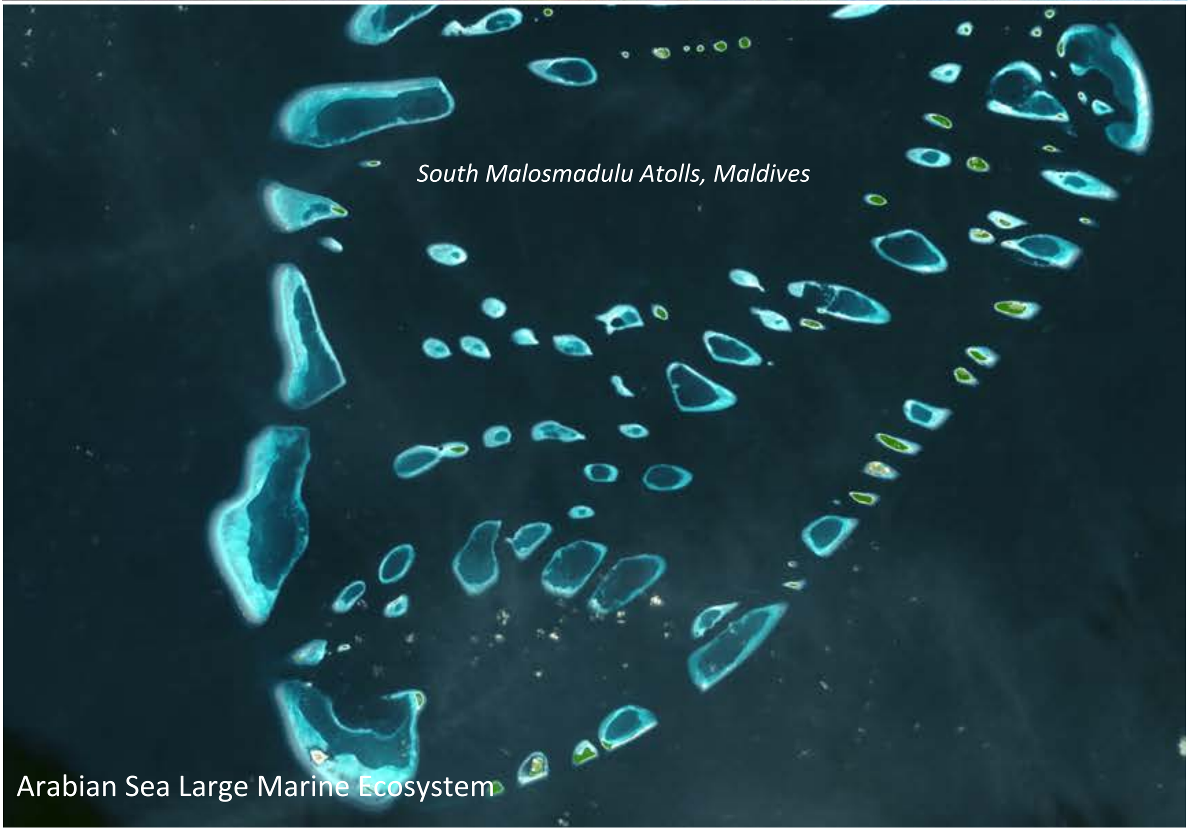
Large Marine Ecosystems of Southern Asia

1. LME 32 – Arabian Sea
2. LME 34 – Bay of Bengal

Center for Marine Assessment and Planning, UCSB



ESA



NASA Earth Observatory

LME 32 – Arabian Sea

Bordering countries: Bahrain, Djibouti, India, Iran, Iraq, Kuwait, Oman, Pakistan, Qatar, Saudi Arabia, Somalia, United Arab Emirates, Yemen.

LME Total area: 3,950,421 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.

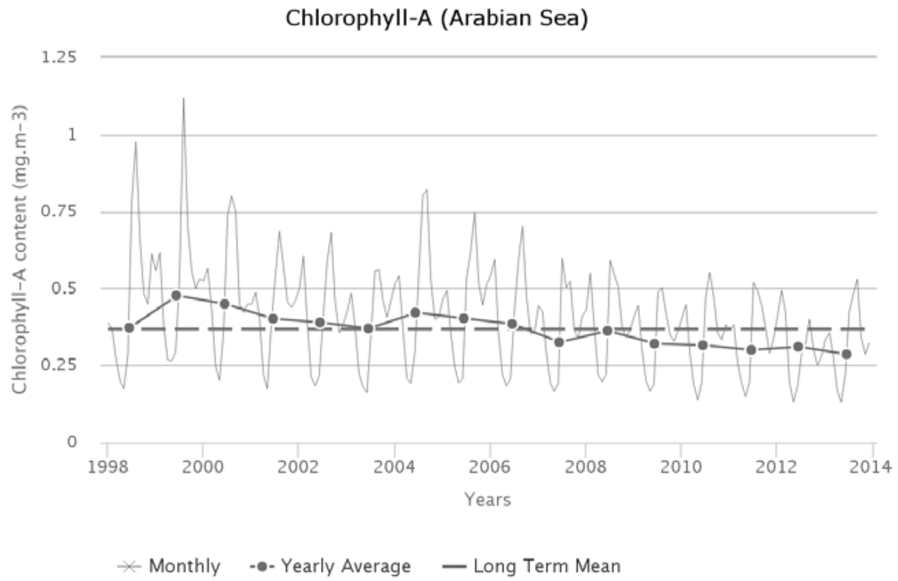
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very high.

Very low | Low | Medium | High | **Very high** ▲

Productivity

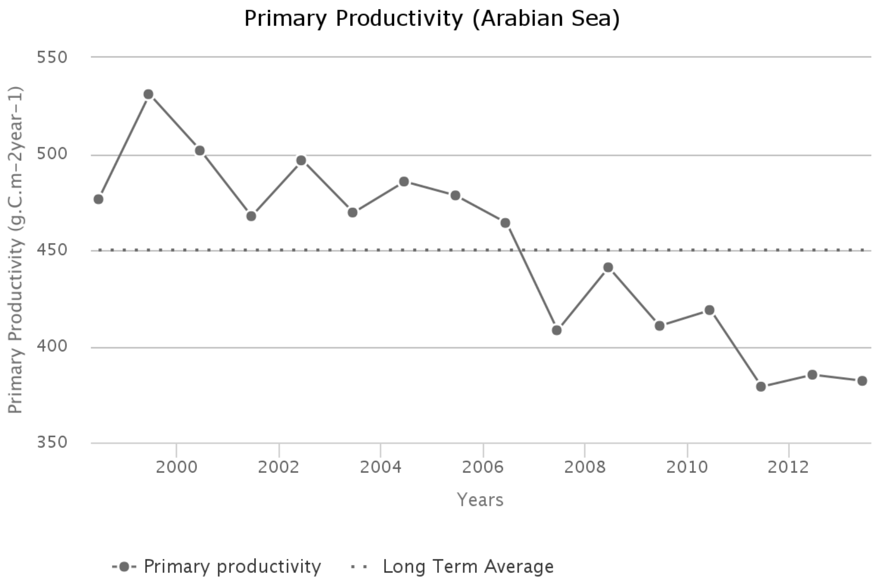
Chlorophyll-A

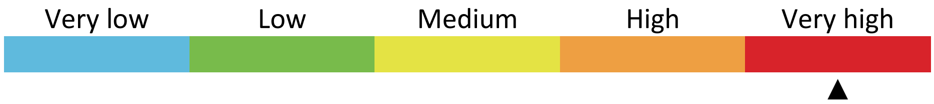
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.674 mg.m^{-3}) in August and a minimum (0.176 mg.m^{-3}) during May. The average CHL is 0.368 mg.m^{-3}. Maximum primary productivity (531 g.C.m^{-2}.y^{-1}) occurred during 1999 and minimum primary productivity (379 g.C.m^{-2}.y^{-1}) during 2011. There is a statistically insignificant decreasing trend in Chlorophyll of -18.2 % from 2003 through 2013. The average primary productivity is 450 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** ▲

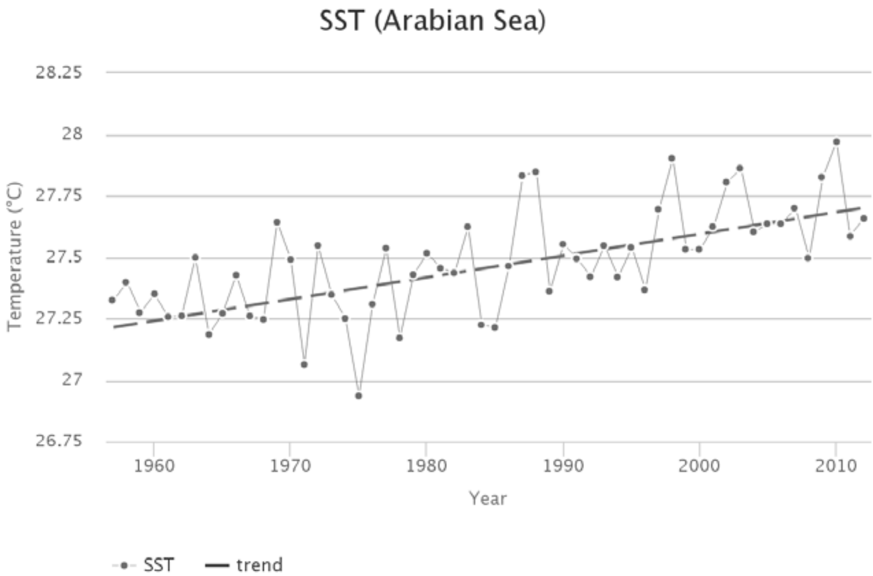
Primary productivity





Sea Surface Temperature

From 1957 to 2012, the Arabian Sea LME #32 has warmed by 0.48°C, thus belonging to Category 3 (moderate warming LME). Like all Indian Ocean LMEs, the Arabian Sea warmed slowly and steadily, except for a sharp drop below 27°C in 1975. Interannual variability of SST in this LME is relative small, with a magnitude of ~0.5°C. The most pronounced event, the all-time minimum of 1975, was likely caused by large-scale forcing since it occurred simultaneously across the entire northern Indian Ocean, including the Red Sea LME #33 and the Bay of Bengal LME #34. The near-all-time maximum of 1998 occurred simultaneously with most Indian Ocean LMEs and only one year before a near-all-time maximum of 1999 in the Red Sea. The rapid warming between 1985 and 1987 ushered in the modern warm epoch in the Arabian Sea. This warming occurred nearly synchronously with a similar warming in the Somali Coastal Current LME #31.

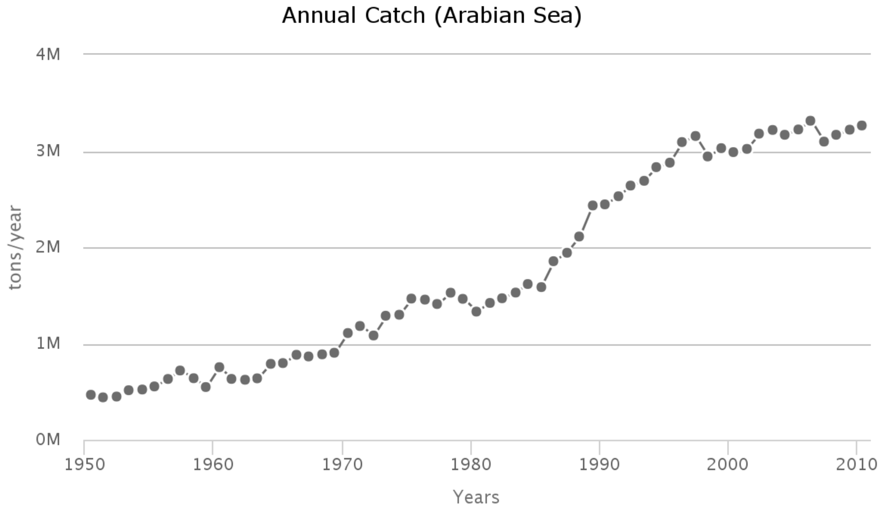


Fish and Fisheries

The fisheries of the Arabian Sea LME are multi-gear and multi-species and include both artisanal and commercial sectors, with the former being dominant. Among the major exploited groups are Indian oil sardine (*Sardinella longiceps*), caught mainly off India's west coast. However, nearly half of the reported landings in the LME are identified only as 'marine fish'.

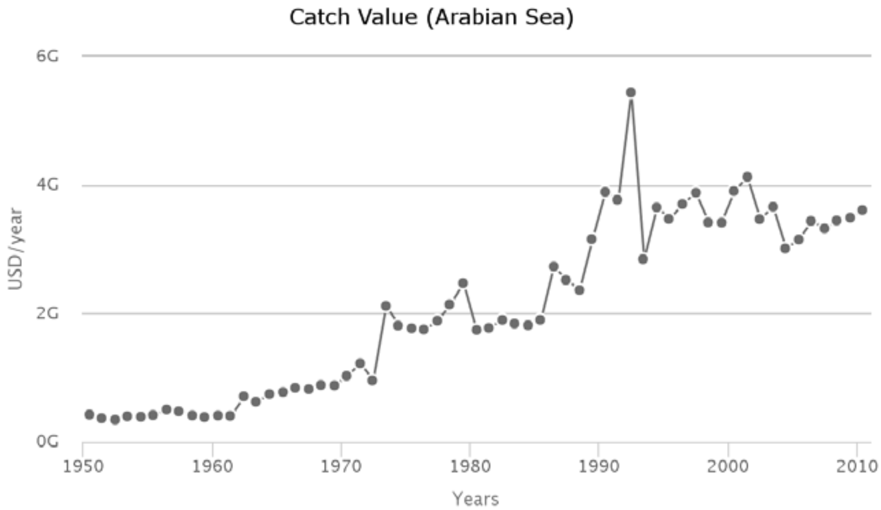
Annual Catch

Total reported landings increased steadily, reaching 3.3 million t in 2006.



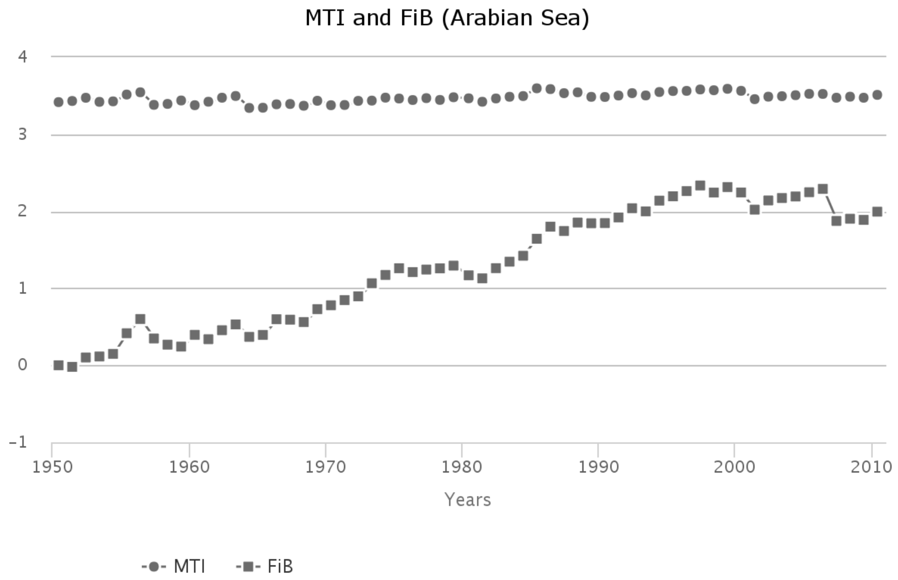
Catch value

The value of the reported landings reached around 5.5 billion US$ (in 2005 value) in 1992.



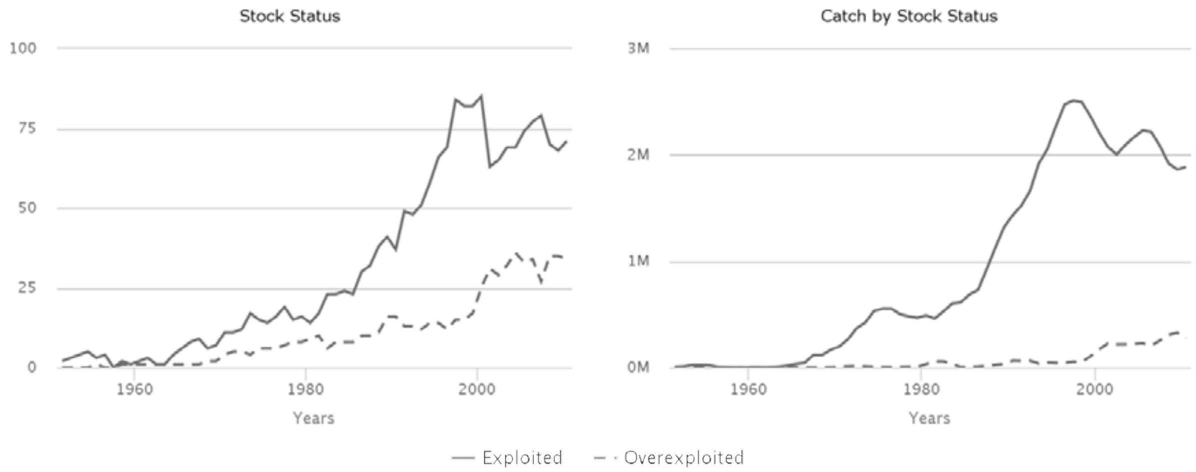
Marine Trophic Index and Fishing-in-Balance index

From the early 1980s to the late 1990s, both the MTI and the FiB index showed an increase, consistent with a spatial (offshore) expansion of fisheries targeting high trophic level large pelagic fishes in the region. However, MTI computed without the landings of tuna and other large pelagic species shows a steady decline since 1975, suggesting the occurrence of a strong 'fishing down' effect.



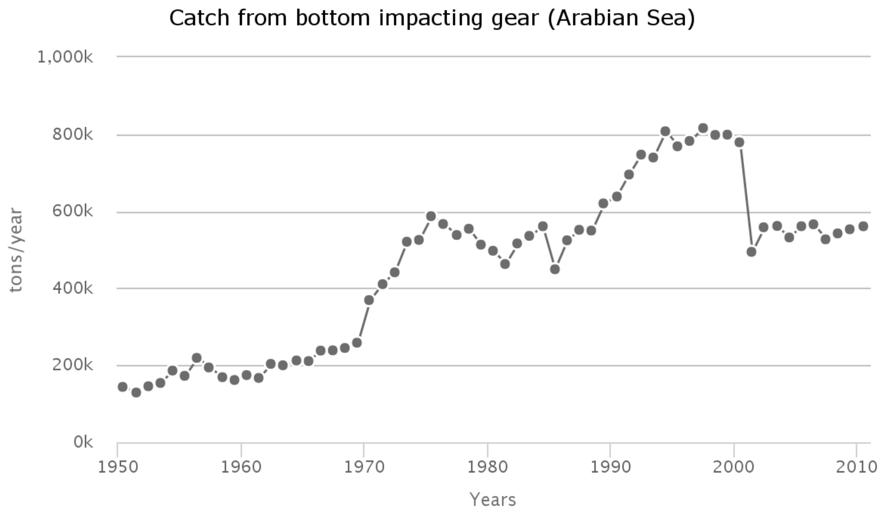
Stock status

The Stock-Catch Status Plots indicate that the number of collapsed and overexploited stocks in the LME have been rapidly increasing, to more than 30% in recent years, but that over 80 % of the catch is still taken from fully exploited stocks.



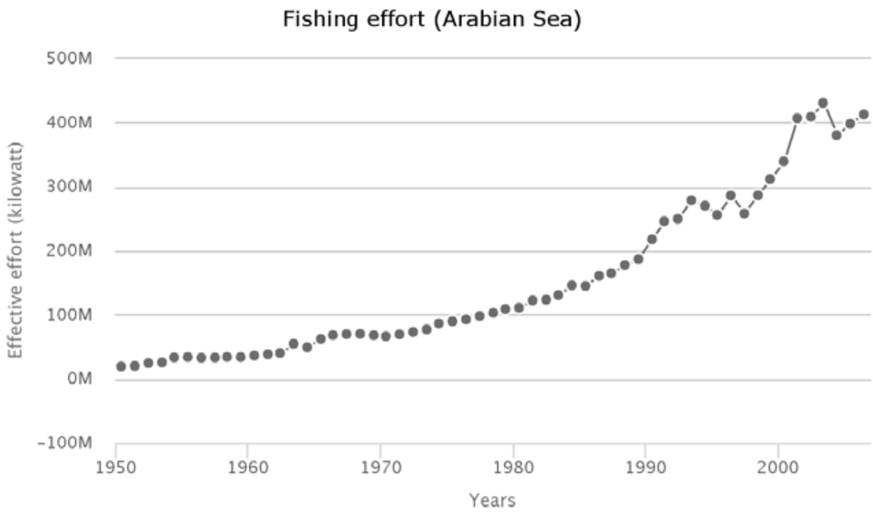
Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch increased from 30% in the 1950s to its first peak at around 40% in 1971. Then, this percentage kept decreasing and fluctuated around 17% in recent decade.



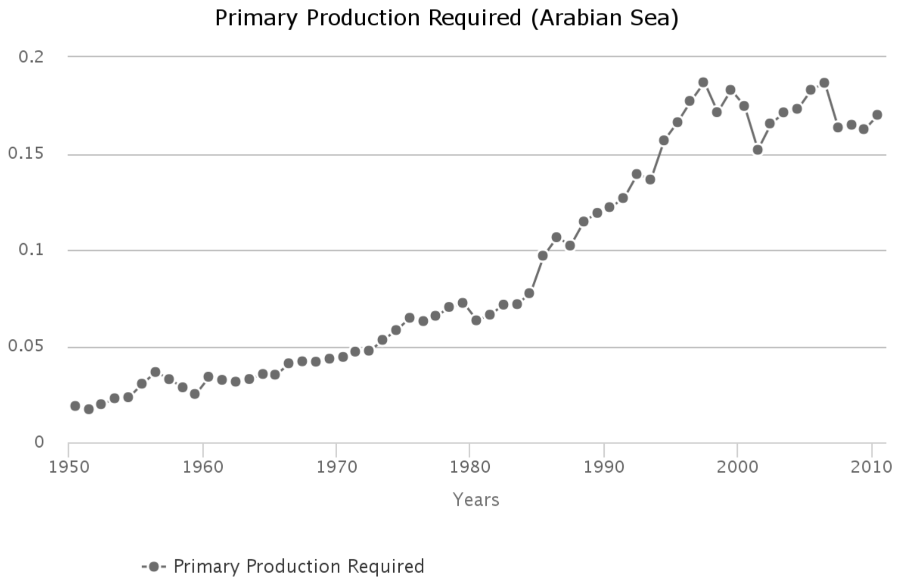
Fishing effort

The total effective effort continuously increased from around 20 million kW in 1950 to its peak around 430 million kW in the mid-2000s.



Primary Production Required

The primary production required (PPR) to sustain the reported landings in this LME reached 20% of the observed primary production in the mid-1990s, but has since declined.



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 moderate (3). According to the Global Orchestration scenario, this remained the same in 2030 and increased to high 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 increased to high in 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	3	3	3	3	3	3	4	4

Legend: Very low, Low, Medium, High, Very high

POPs

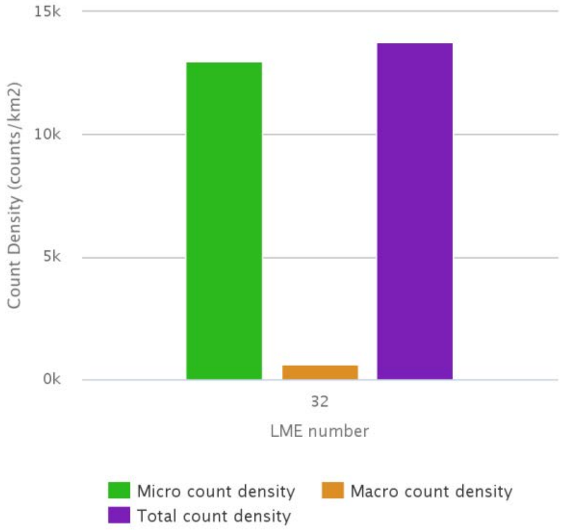
Data are available for only one sample at one location in Mumbai, India. This location shows moderate concentration for PCBs (53 ng.g^{-1} of pellets), corresponding to risk category 3, and low concentration for DDTs (10 ng.g^{-1}) and minimal concentration for HCHs (1.8 ng.g^{-1}), corresponding to risk category 2 of the five risk categories (1 = lowest risk; 5 = highest risk). Moderate concentration of PCBs could be derived from old electronic instruments. Due to the rapid economic growth and associated pollution concerns, extensive monitoring is necessary in this LME.

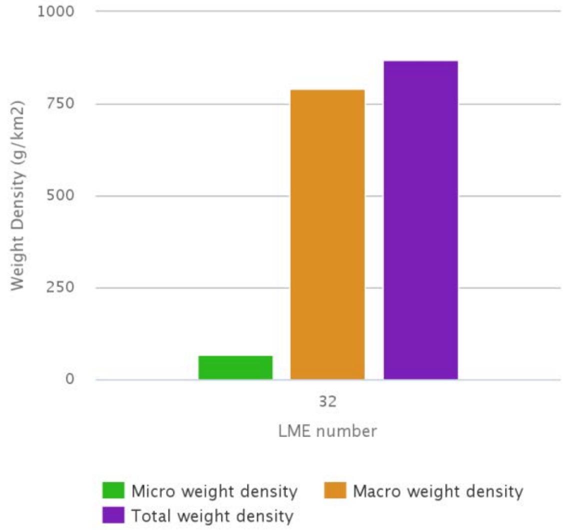
	PCBs		DDTs		HCHs	
Locations	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk
1	53	**3**	10	**2**	1.8	**1**

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 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 limited evidence from sea-based direct observations and towed nets to support this conclusion.





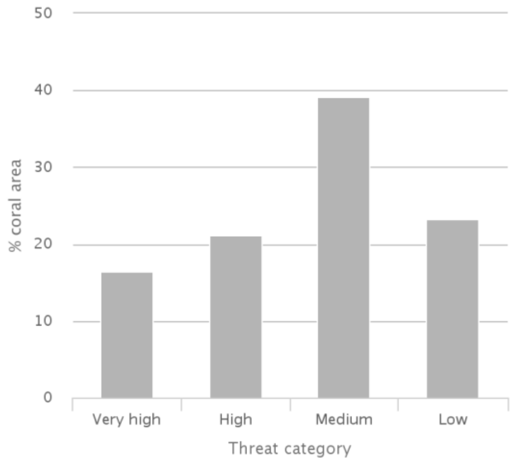
Ecosystem Health

Mangrove and coral cover

0.03% of this LME is covered by mangroves (US Geological Survey, 2011) and 0.1% 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 231. 22% of coral reefs cover is under very high threat, and 15% 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 24% and 25% for very high and high threat categories respectively. By year 2030, 23% 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 37% by 2050.

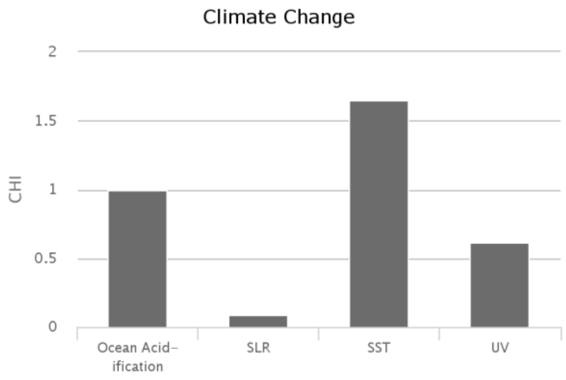


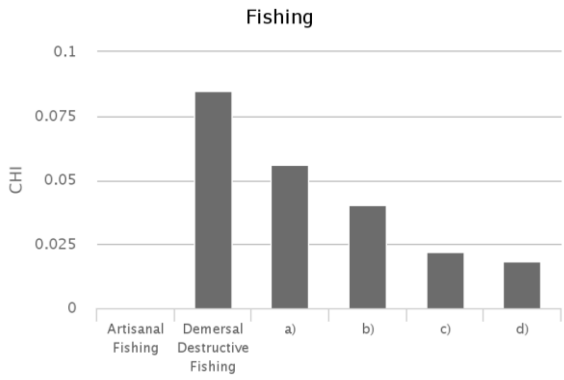
Marine Protected Area change

The Arabian Sea LME experienced an increase in MPA coverage from 2,071 km^2 prior to 1983 to 12,449 km^2 by 2014. This represents an increase of 501%, within the low category of MPA change.

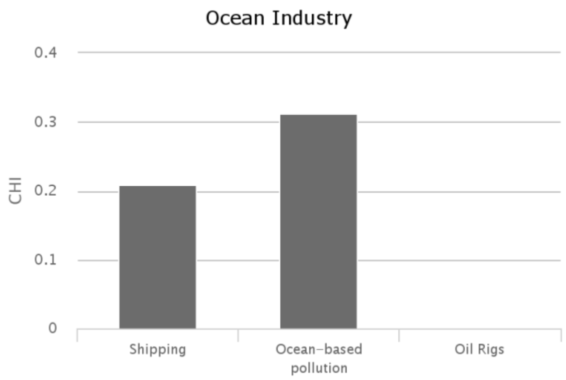
Cumulative Human Impact

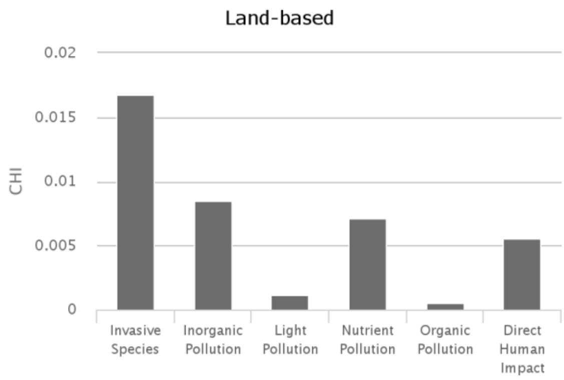
The Arabian Sea LME experiences an above average overall cumulative human impact (score 4.12; maximum LME score 5.22), which is also well above the LME with the least cumulative impact. It falls in risk category 4 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (1.00; maximum in other LMEs was 1.20), UV radiation (0.61; maximum in other LMEs was 0.76), and sea surface temperature (1.65; maximum in other LMEs was 2.16). Other key stressors include commercial shipping, sea level rise, ocean based pollution, demersal destructive commercial fishing, and demersal non-destructive low-bycatch commercial fishing.



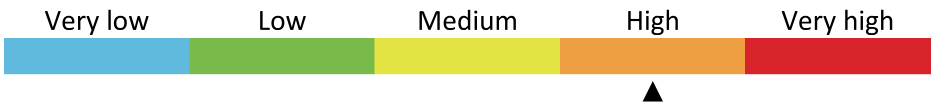


a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing





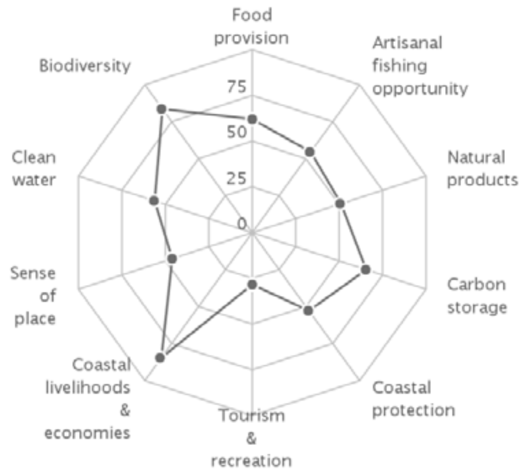
CHI: 4.12



Ocean Health Index

The Arabian 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 mariculture, coastal protection, tourism & recreation, and sense of place goals and highest on artisanal fishing opportunities and coastal economies goals. It falls in risk category 5 of the five risk categories, which is the highest level of risk (1 = lowest risk; 5 = highest risk).

Ocean Health Index (Arabian Sea)



OHI: 58.54

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 513 873 km^2. A current population of 27 950 thousand in 2010 is projected to increase to 108 998 thousand in 2100, with a density of 54 persons per km^2 in 2010 reaching 202 per km^2 by 2100. About 58% of coastal population lives in rural areas, and is projected to increase in share to 68% in 2100.

Total population		Rural population	
2010	**2100**	**2010**	**2100**
192,379,489	316,830,284	94,565,089	164,612,205

Legend: Very low | Low | Medium | High | Very high

Coastal poor

The indigent population makes up 24% of the LME's coastal dwellers. This LME places in the very high-risk category based on percentage and in the high-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
43,095,719

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the low-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $230 million for the period 2001-2010. Fish protein accounts for 9% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013 $12 134 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 high risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
4,130,753,748	11.7	53,384,607,318	7.2	0.7750

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 low HDI and high-risk category. Based on an HDI of 0.648, this LME has an HDI Gap of 0.352, 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 increased population values from those in a sustainable development pathway.

HDI	HDI 2100	
	SSP1	SSP3
0.6184	0.8529	0.4432

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 high-risk (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 high. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and increases to very high risk under a fragmented world development pathway.

2010		2100	
Climate Threat	Contemporary Threat	SSP1	SSP3
0.9389	0.4828	0.4650	0.7248

Legend:

Very low | Low | Medium | High | Very high

Governance

Governance architecture

While this LME has two separate regional seas agreements (in place covering pollution (LBS and MBS) and biodiversity (Kuwait and Jeddah Conventions and protocols), no overarching 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. In terms of transboundary fisheries arrangements, these are also not formally integrated although informal linkages may be present at some level.

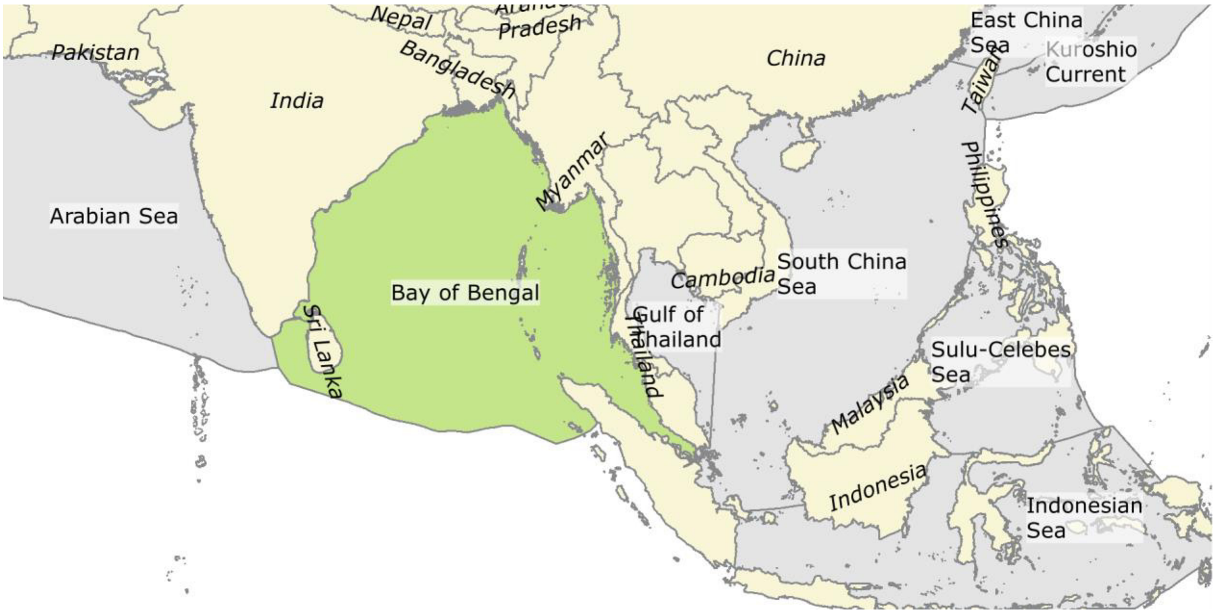
The overall scores for ranking of risk were:

Engagement	Completeness	Integration
86	**45**	**0.1**

Legend:

Very low | Low | Medium | High | Very high

LME 34 – Bay of Bengal



Bordering countries: Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka, Thailand.
LME Total area: 3,657,502 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.

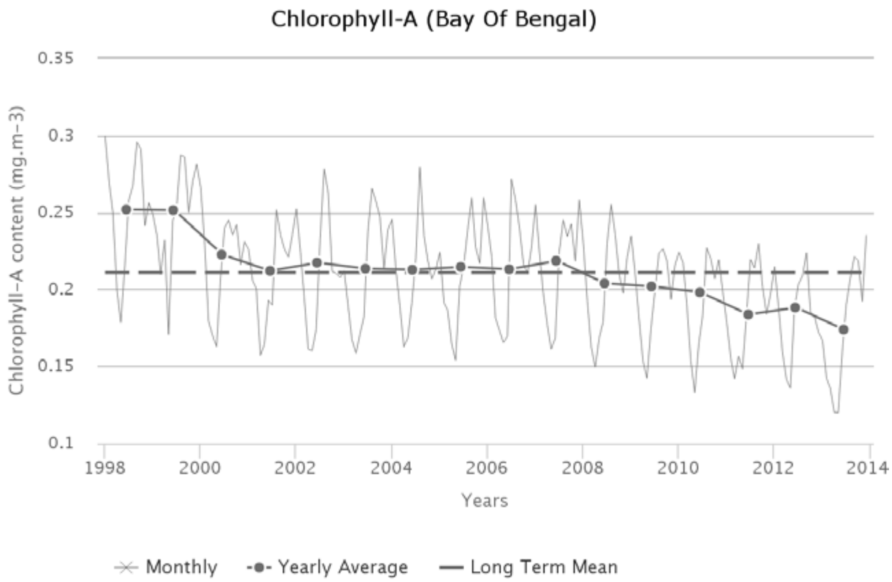
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very high.

Very low	Low	Medium	High	Very high
				▲

Productivity

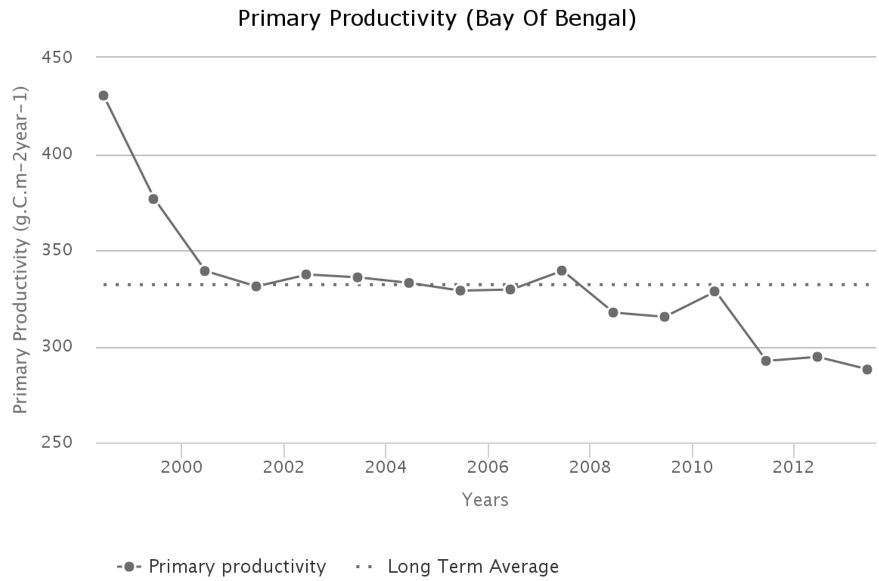
Chlorophyll-A

The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.253 $mg.m^{-3}$) in August and a minimum (0.162 $mg.m^{-3}$) during May. The average CHL is 0.211 $mg.m^{-3}$. Maximum primary productivity (430 $g.C.m^{-2}.y^{-1}$) occurred during 1998 and minimum primary productivity (288 $g.C.m^{-2}.y^{-1}$) during 2013. There is a statistically insignificant decreasing trend in Chlorophyll of -5.76 % from 2003 through 2013. The average primary productivity is 332 $g.C.m^{-2}.y^{-1}$, which places this LME in Group 4 of 5 categories (with 1 = lowest and 5= highest).



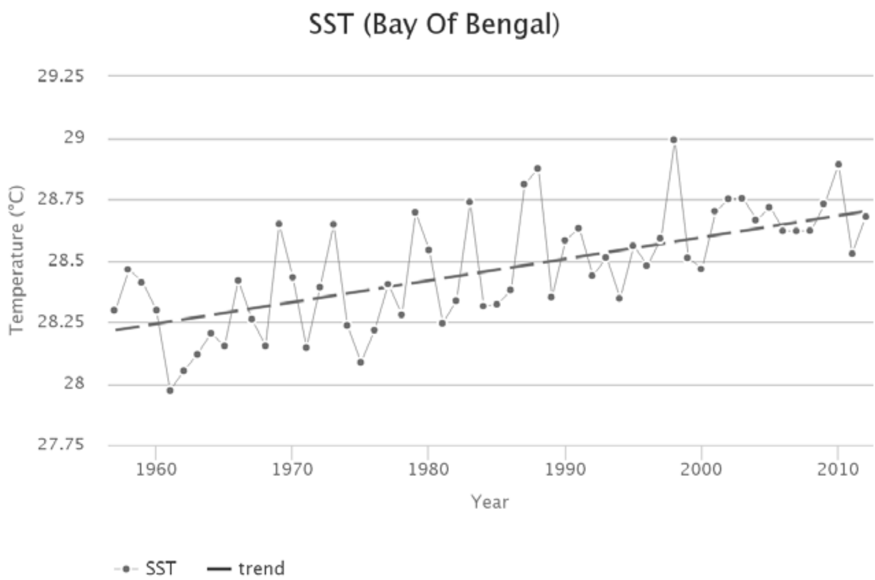
Very low	Low	Medium	High	Very high
			▲	

Primary productivity



Sea Surface Temperature

From 1957 to 2012, the Bay of Bengal LME #34 has warmed by 0.53°C, thus belonging to Category 3 (moderate warming LME). The steady warming of the Bay of Bengal was modulated by interannual (every 3-to-5 years) variations with a typical magnitude of <0.5°C. The all-time maximum of 1998 occurred simultaneously with other Indian Ocean LMEs and could be linked to the El Niño 1997-1998. Temperature history of the Bay of Bengal is linked to its salinity regime and freshwater discharge of three great rivers, Ganges, Brahmaputra and Irrawaddy. Interannual variability of the Indian monsoon largely determines the river discharge, hence salinity regime and eventually SST variability, in the Bay of Bengal LME.

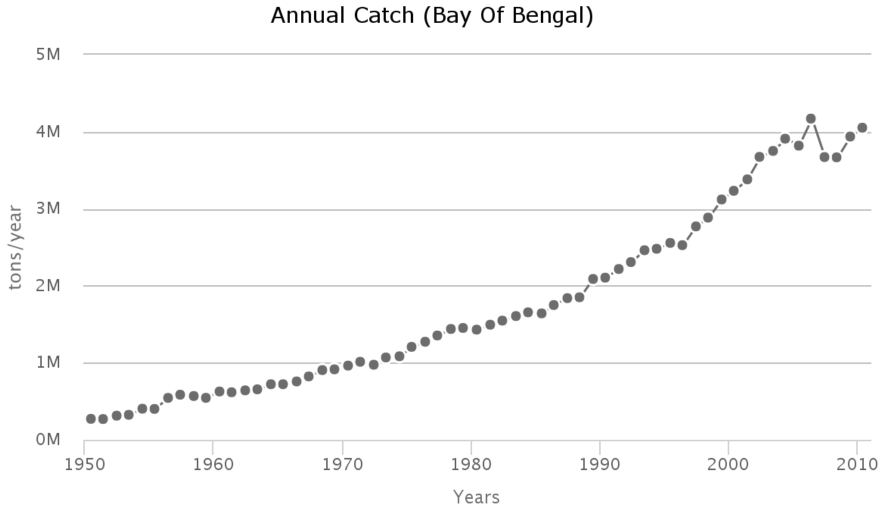


Fish and Fisheries

The fisheries of the Bay of Bengal LME target a wide range of species, including sardine, anchovy, scad, shad, mackerel, snapper, emperor, grouper, pike-eel, tuna, shark, shrimp, bivalve and other shellfish.

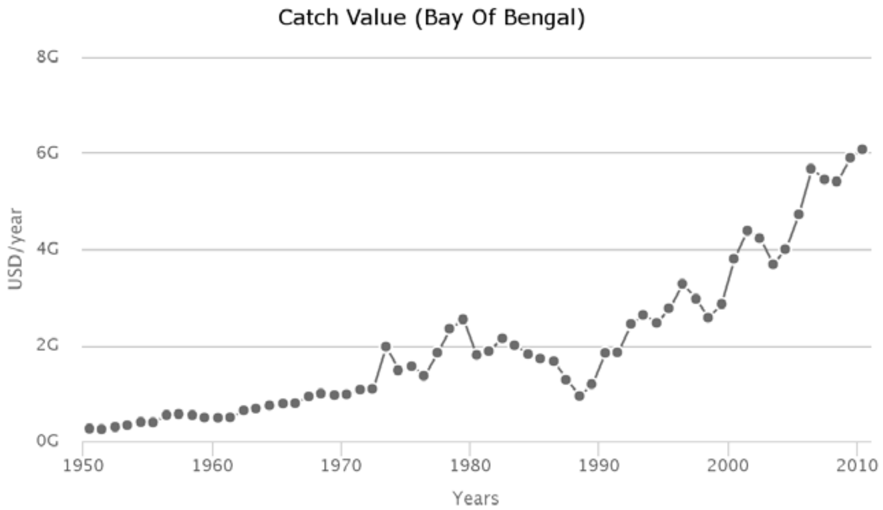
Annual Catch

Catches from commercial and subsistence fishing equal or exceed those from industrial fisheries. During the last decade, several countries have developed offshore fishing for tuna. There are strong indications that the continuous increase in the reported landings, particularly of unidentified fishes is a product of deficiencies in the underlying statistics, rather than improvements in the performance of the fisheries in the LME.



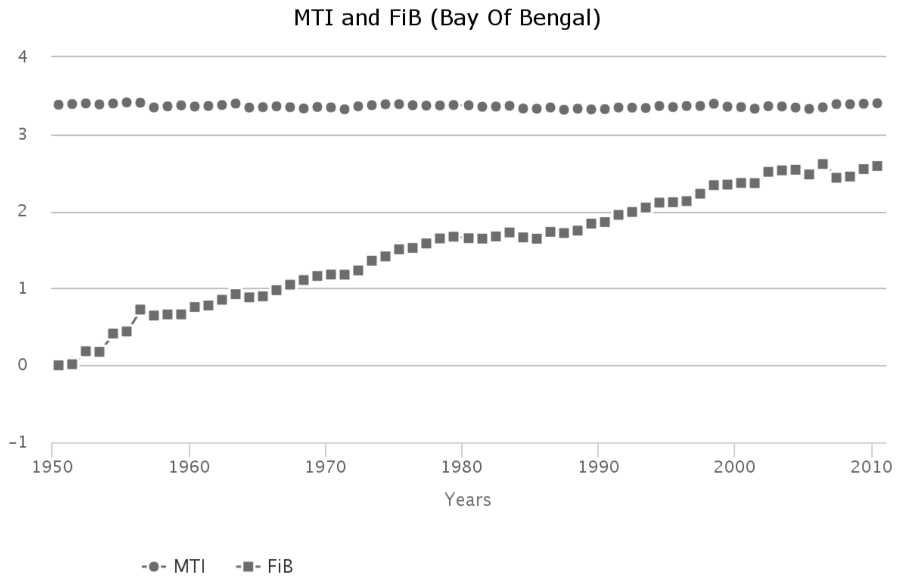
Catch value

Reported landing rose to about 1.2 million t in 2006 and the value of the reported landing reached a peak of about 5.7 billion US$ (in 2005 real US$) in the recent 5 years (2006 – 2010), but this figure is also questionable.



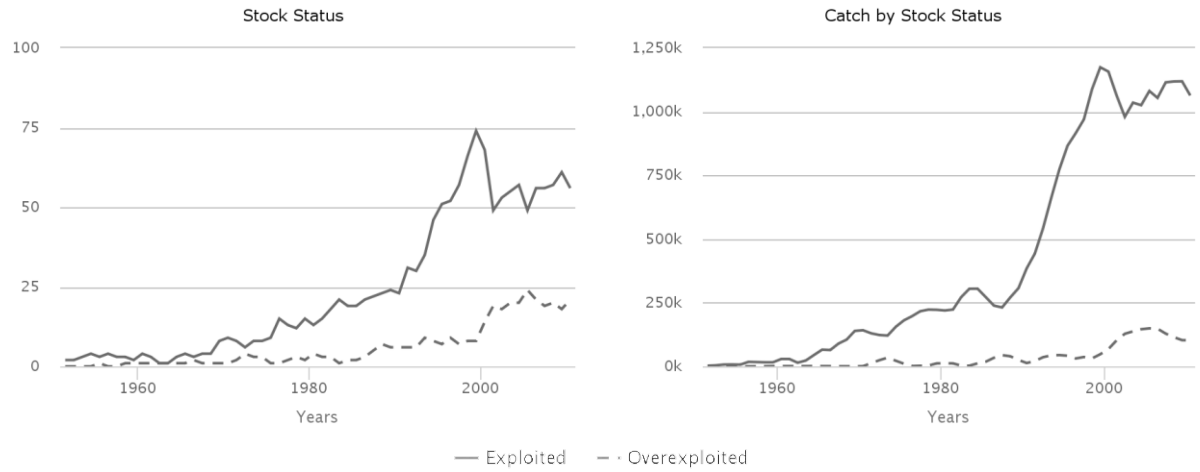
Marine Trophic Index and Fishing-in-Balance index

The MTI shows a steady decline over the past 60 years, while the FiB index increased over the same period. Due to the nature of the underlying landings statistics, it is not difficult to draw reliable conclusions from these indices; however, a detailed analysis of the MTI and FiB index of Western India, found that a 'fishing down' of the food webs indeed occurs in the region.



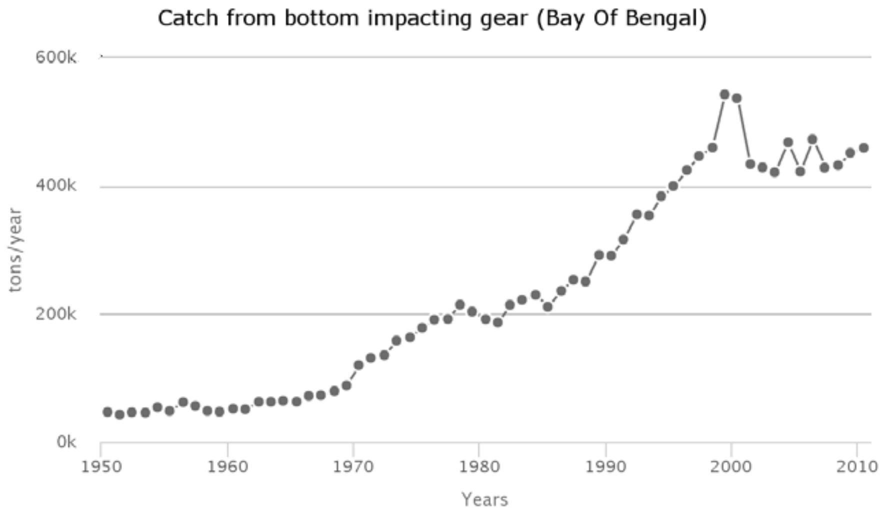
Stock status

The Stock-Catch Status Plots indicate that the number of collapsed and overexploited stocks in the LME is low but on the rise, with over 50% of the reported landings from fully exploited stocks. Again, the questionable quality of the underlying landings statistics must be noted.



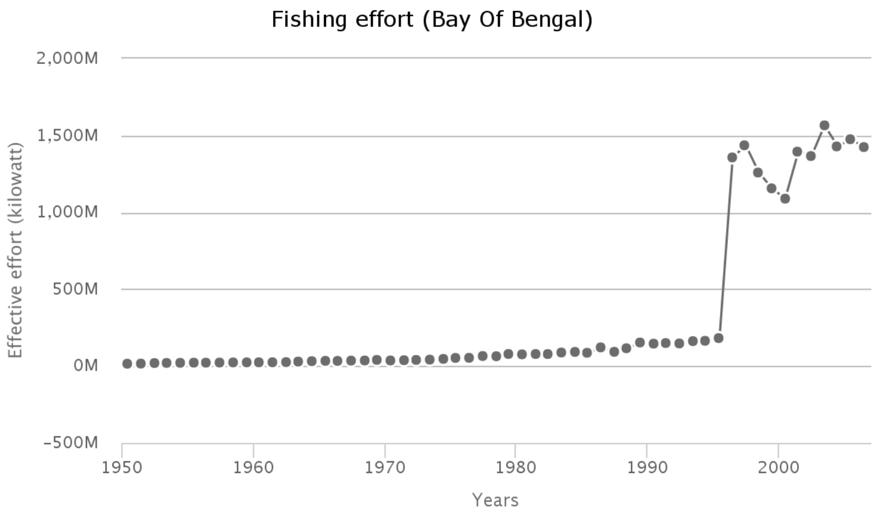
Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch decreased from 17% in 1950 to around 8% in the 1960s. Then, this percentage fluctuated between 10 and 18% in the following years.



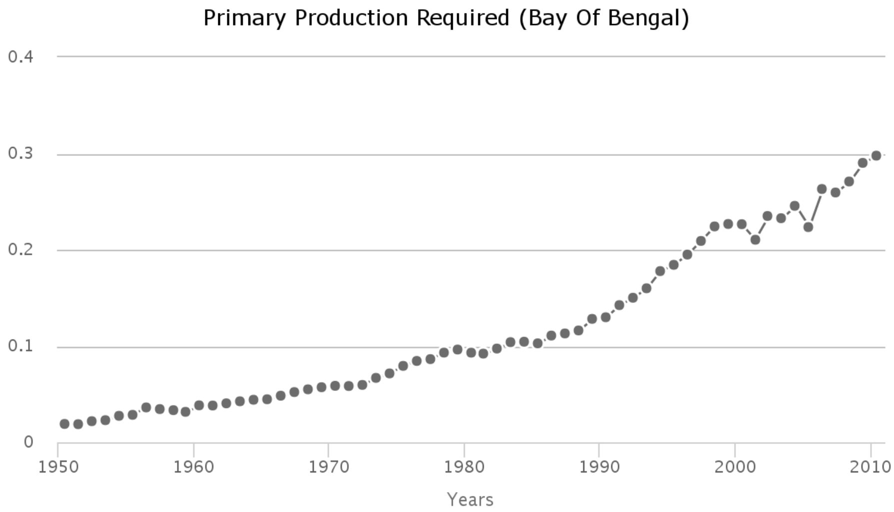
Fishing effort

The total effective effort was below 200 million kW from 1950 to the mid-1990s. Then, it increased sharply to 1,400 million kW in 1996 and it fluctuated around 1,400 million kW in the recent decade.



Primary Production Required

The primary production required (PPR) to sustain the reported landings in this LME has increased over the years, and reached 20% of the observed primary production in 1998, which may be another indication that the reported landings for this LME is overestimated.



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

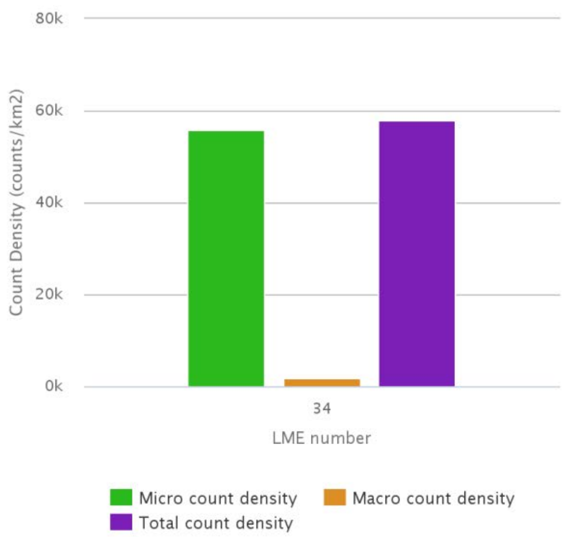
This LME covers the east coast of India, Sri Lanka and the west coast of Malaysia. Five samples at five locations are available. Average concentrations (ng.g^{-1} of pellets) were low: 36 (range 2-139 ng.g^{-1}) for PCBs, 17 (range 1-3 ng.g^{-1}) for DDTs, and 4.7 (range 3.2-6.2 ng.g^{-1}) for HCHs. All indicators correspond to risk category 2 of the five risk categories (1 = lowest risk; 5 = highest risk). Higher PCBs concentration at Chennai, India (139 ng.g^{-1}) may come from old electronic instruments, although the other location shows almost background level. Moderate concentrations of HCHs at a location in Port Dickson, Malaysia (6.2 ng.g^{-1} pellet) may suggest current usage of Lindane pesticide. Continuous monitoring and increase in spatial coverage is recommended.

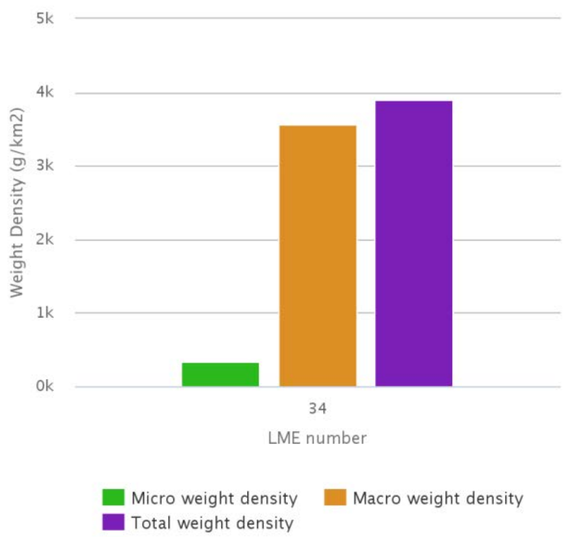
	PCBs		DDTs		HCHs	
Locations	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk
5	36	**2**	17	**2**	4.7	**2**

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 good evidence from sea-based direct observations and towed nets to support this conclusion.





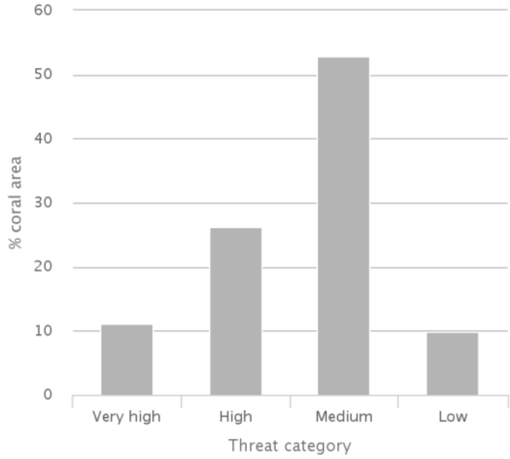
Ecosystem Health

Mangrove and coral cover

0.52% of this LME is covered by mangroves (0.52% of this LME is covered by mangroves (US Geological Survey, 2011) and 0.13% by coral reefs (Global Distribution of Coral Reefs, 2010).) and 0.13% 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 238. 11% of coral reefs cover is under very high threat, and 26% 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 21% and 27% for very high and high threat categories respectively. By year 2030, 23% 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 37% by 2050.

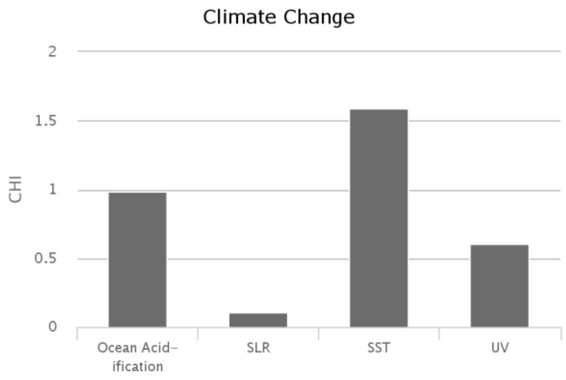


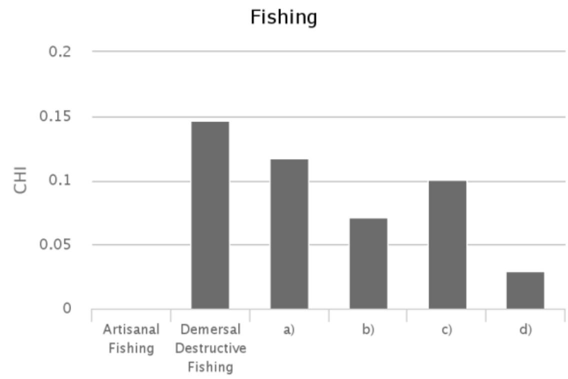
Marine Protected Area change

The Bay of Bengal LME experienced an increase in MPA coverage from 4,354 km2 prior to 1983 to 10,687 km2 by 2014. This represents an increase of 145%, within the low category of MPA change.

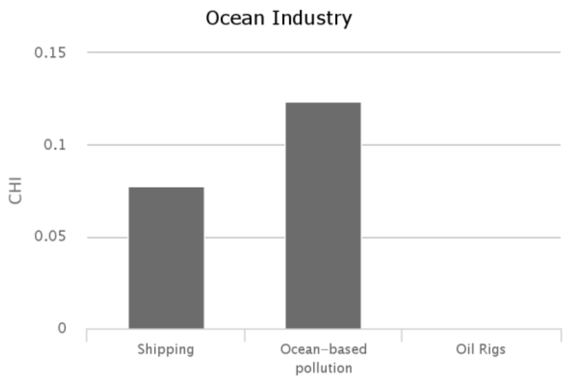
Cumulative Human Impact

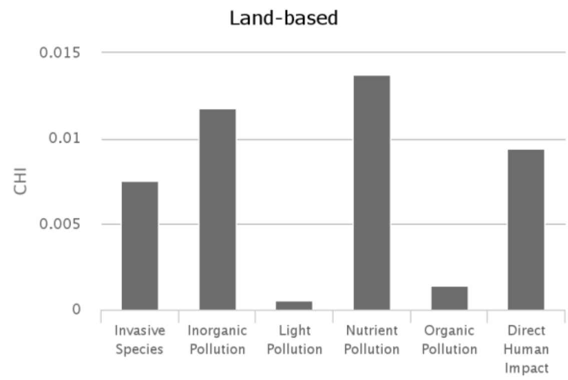
The Bay of Bengal LME experiences an above average overall cumulative human impact (score 4.00; maximum LME score 5.22). It falls in risk category 4 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (0.98; maximum in other LMEs was 1.20), UV radiation (0.61; maximum in other LMEs was 0.76), and sea surface temperature (1.59; maximum in other LMEs was 2.16). Other key stressors include commercial shipping, sea level rise, ocean based pollution, pelagic high-bycatch commercial fishing, and all three types of demersal commercial fishing (demersal destructive, non-destructive low-bycatch, and non-destructive high-bycatch).





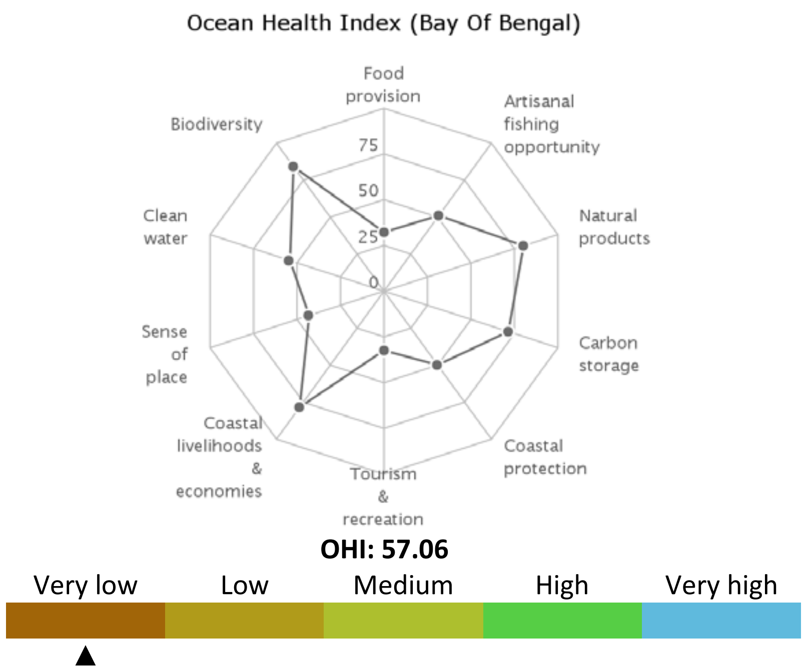
a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing





Ocean Health Index

The Bay of Bengal LME scores below average on the Ocean Health Index compared to other LMEs (score 62 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 increase 2 points 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, tourism & recreation, and sense of place goals and highest on artisanal fishing opportunities, coastal economies, and habitat biodiversity goals. 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 874 413 km^2. A current population of 323 389 thousand in 2010 is projected to increase to 501 774 thousand in 2100, with a density of 370 persons per km^2 in 2010 reaching 574 per km^2 by 2100. About 64% of coastal population lives in rural areas, and is projected to increase in share to 67% in 2100.

Total population		Rural population	
2010	**2100**	**2010**	**2100**
323,388,537	501,774,392	205,745,155	333,816,233

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 25% of the LME's coastal dwellers. This LME places in the very high-risk category based on percentage and in the very high-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
81,353,809

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 $5 891 million for the period 2001-2010. Fish protein accounts for 32% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$57 951 million places it in the high-revenue category. On average, LME-based tourism income contributes 15% 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
5,891,137,757	32.4	57,222,138,090	14.6	0.8045

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 low HDI and very high-risk category. Based on an HDI of 0.604, this LME has an HDI Gap of 0.396, 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 increased population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.6037	0.8605	0.4429

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 risk under a fragmented world development pathway.

2010		2100	
Climate Threat	**Contemporary Threat**	**SSP1**	**SSP3**
1.0000	0.5923	0.4545	0.7210

Legend: Very low, Low, Medium, High, Very high

Governance

Governance architecture

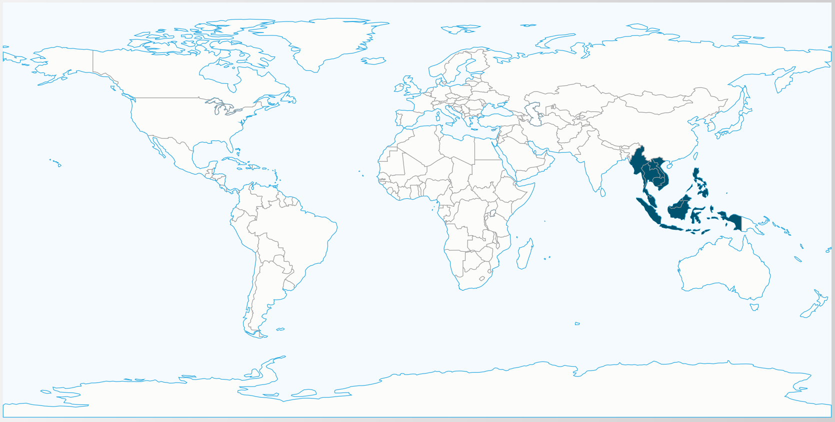
This LME is served by two Regional Seas Programme initiatives and several transboundary fisheries arrangements only one of which, the BOB IGO, is focussed on the LME. There does not appear to be any agency that is formally mandated to provide transboundary integration for the issues dealt with above. The BOBLME Project may be filling this role in an unofficial capacity. It also supports integration by facilitating and catalyzing cooperative activities and capacity development.
The overall scores for ranking of risk were:

Engagement	Completeness	Integration
87	**50**	**0.1**

Legend: Very low, Low, Medium, High, Very high

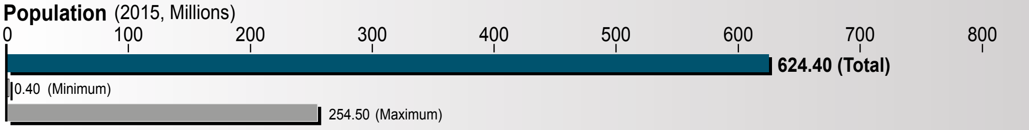
Regional Risks by Theme

TRANSBOUNDARY WATERS: SOUTHEASTERN ASIA

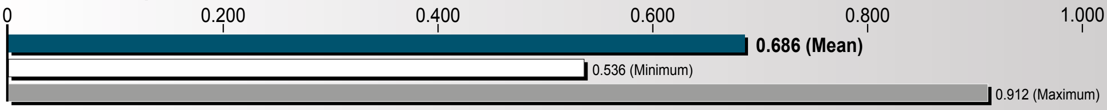


The region has an average Human Development Index of 0.686, belonging to the Medium HDI group with a total population of 624 million in 2015. Contemporary risks of water systems by water category and theme expressed as percentages are shown at top right. Pooling across 40 transboundary water systems in the region (bottom left), 37% (10% + 27%) of the water systems are at high to highest socioeconomic risk, 36% are subject to the highest governance risk, and 50% (28% + 22%) are at moderate to high biophysical risk. On average, the region's transboundary waters (bottom right) are subject to high socioeconomic and governance risks and to moderate biophysical risks. LMEs are at high risk and aquifers and river basins are at moderate risks across all risk themes.

Population (2015, Millions)

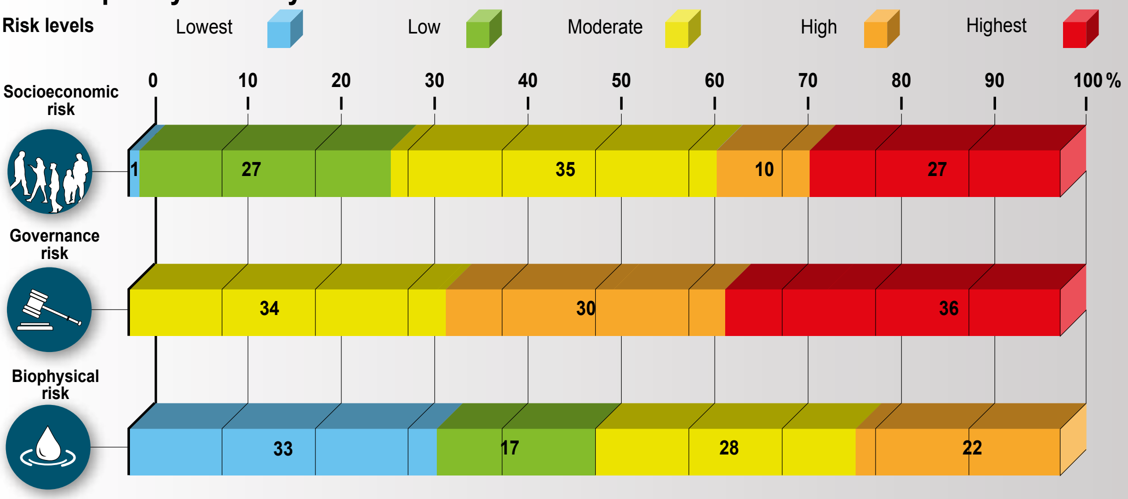


Human Development Index (2014)



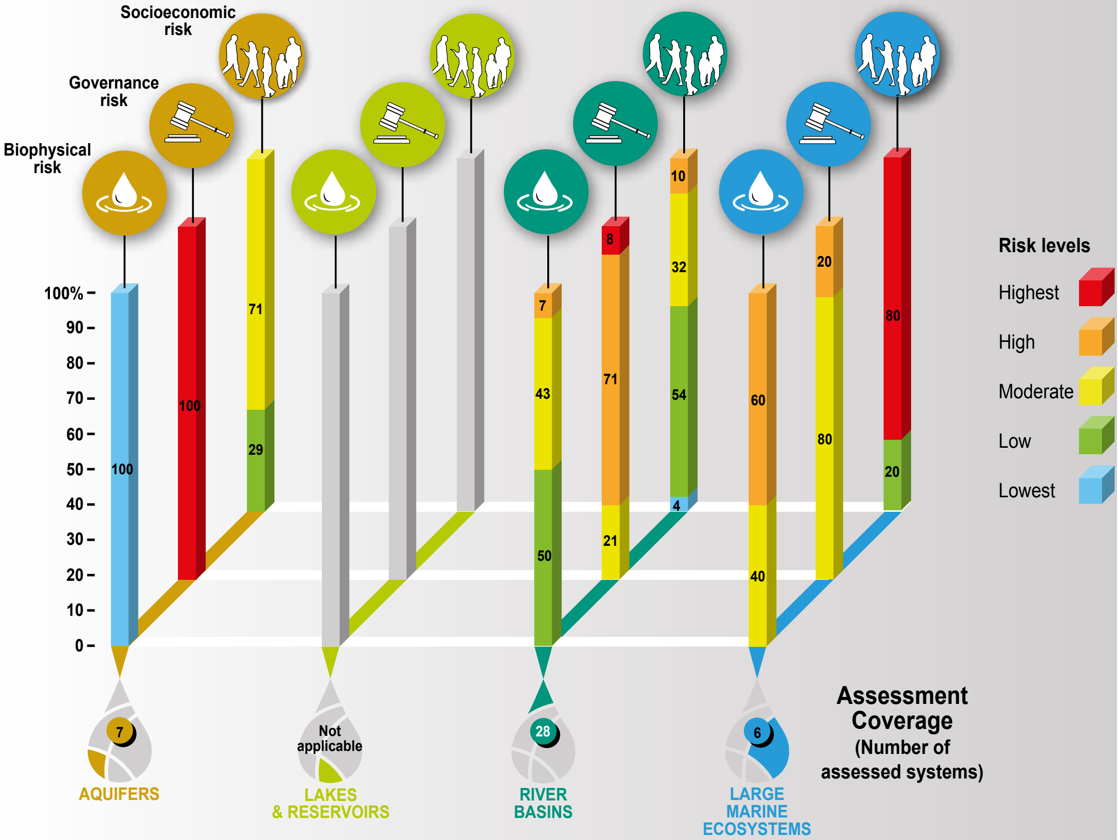
Per Capita Income (2015, US$)

Contemporary Risks by Theme

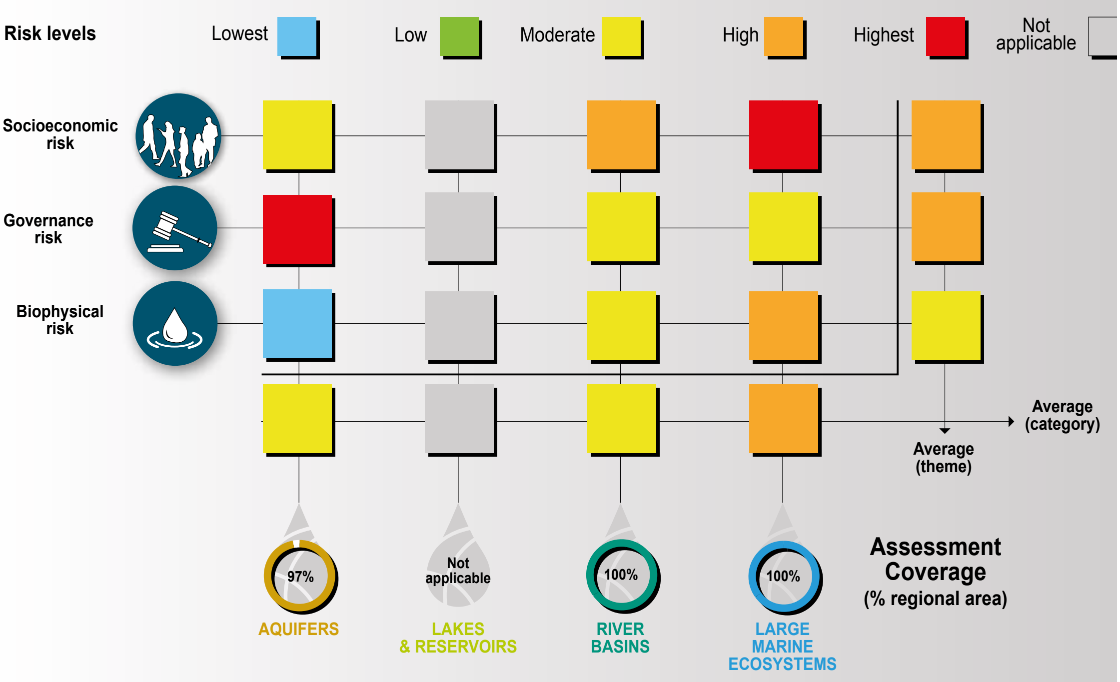


Regional Risks by Water Category

Contemporary Risks by Water Category



Average Risks



Transboundary Aquifers of Southeastern Asia

1. Cambodia Mekong River Delta Aquifer
2. Downstream of Lancang River
3. Hong River Basin
4. Karst Aquifer of Upper Zuojiang Valley
5. Khorat Plateau Aquifer
6. Limbang Aquifer
7. Lower Mekong River 1 Aquifer
8. Lower Mekong River 2 Aquifer
9. Nu River Valley Aquifer
10. Salween River Aquifer

United Nations Educational, Scientific and Cultural Organization
International Hydrological Programme
International Groundwater Resources Assessment Centre
Goethe Universität Frankfurt am Main
Simon Fraser University Engaging the World

AS89 - Cambodia Mekong River Delta Aquifer

Geography

Total area TBA (km^2): 180 000

No. countries sharing: 3

Countries sharing: Cambodia, Thailand, Vietnam

Population: 39 000 000

Climate Zone: Tropical Dry

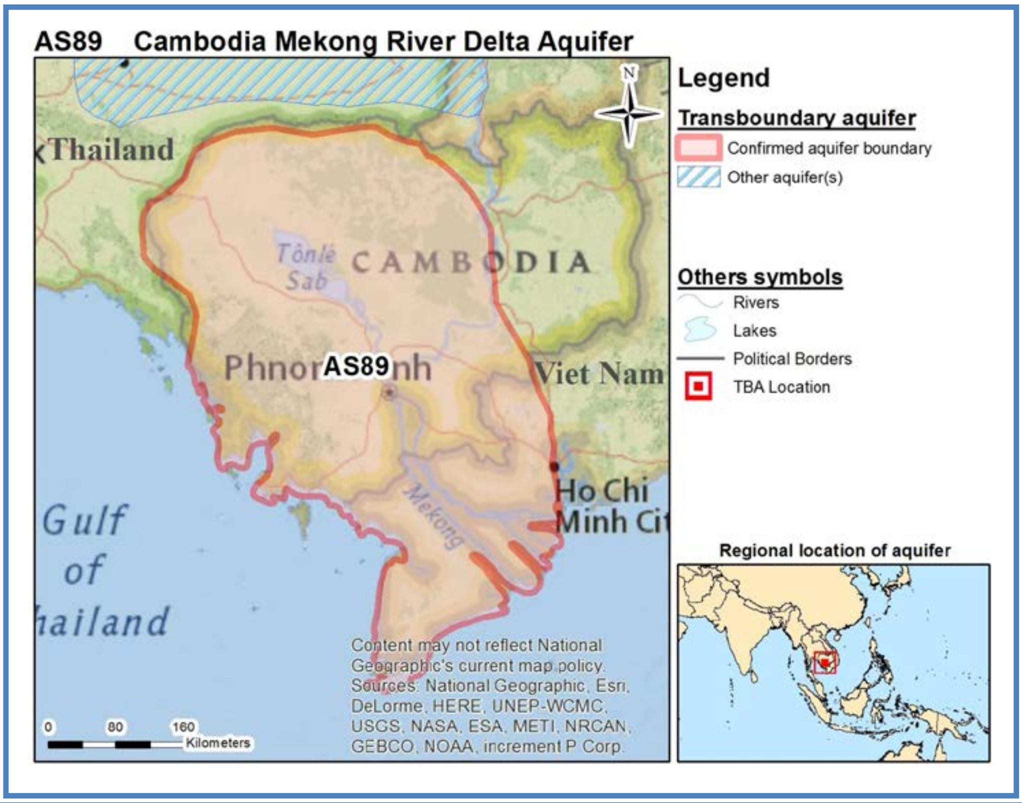
Rainfall (mm/yr): 1700

Hydrogeology

Aquifer type: Multiple layers hydraulically connected

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

Main Lithology: Sediment - gravel



No cross-section available

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

AS89 - Cambodia Mekong River Delta 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)
Cambodia	<1	<1	80	10		B	120	>1000		
Thailand							69			
Viet Nam							510			
TBA level							**220**			

(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)				
Cambodia	250	2400	-28	-39	0	3	0	1
Thailand	420	4500	-16	-20	2	21	0	0
Viet Nam	440	930	-16	-20	1	3	0	2
TBA level	**300**	**1500**	**-23**	**-30**	**1**	**3**	**0**	**2**

	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)
Cambodia	3	110	33	56	<1	0	0
Thailand	3	92	13	18	<1	0	0
Viet Nam	-1	480	21	28	1	0	1
TBA level	**2**	**200**	**25**	**39**	**1**	**0**	**0**

AS89 - Cambodia Mekong River Delta 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	Av. Transmissivity (m^2/d)
Cambodia	5	100	15	Aquifer mostly confined, but some parts unconfined	Sediment - Gravel	High primary porosity fine/ medium sedimentary deposits		1000
Thailand								
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 Cambodia, most of the values within this brief refer to the portion of the TBA within Cambodia.

Aquifer geometry

This aquifer is a multiple-layered hydraulically connected system that is mostly confined, but some parts are unconfined. The average depth to the water table is 5 m, and the average depth to the top of the aquifer is 100 m while the average thickness of the aquifer system is 15 m.

Hydrogeological aspects

The predominant aquifer lithology is sediment – gravel that has a high primary porosity and a high vertical connectivity. The average transmissivity value is 1000 m^2/d. The average recharge into the system is 17.6 Mm^3/yr.

Linkages with other water systems

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

Environmental aspects

Within Cambodia around 20% of the aquifer area is unsuitable for human consumption over a significant part of the aquifer and this is largely due to elevated levels of arsenic. Some anthropogenic groundwater pollution has been identified/ suspected but the data is not available to determine the percentage of the aquifer area that has been affected. It is estimated that around 10% of the aquifer area within Cambodia is polluted within the superficial layers. The main causes are through households and agricultural practices resulting in salinisation, and excessive amounts of pesticides. Although most of the aquifer within Cambodia is characterised by shallow groundwater, no data is available on the percentage of the area that is covered with shallow groundwater nor on the extent of groundwater dependent ecosystems.

Socio-economic aspects

A total amount of 145 Mm^3 of groundwater was abstracted from the system during 2010 within Cambodia. The total amount of fresh water that was abstracted over the aquifer area within Cambodia for the same year was 1 678Mm^3.

AS89 - Cambodia Mekong River Delta Aquifer

Legal and Institutional aspects

The Mekong River Commission does provide a platform for Transboundary cooperation although the status and mandate with respect to Transboundary matters has not been recorded. At a national level there is an institution that manages the groundwater resources but the extent of the mandate and capacity is uncertain.

Priority Issues

Population increase within the area is increasing the use of groundwater resulting in groundwater decline (amount not recorded). This matter together with the problem of a high concentrations of arsenic within parts of the aquifer, are matters that must be further investigated. Furthermore mechanisms to cooperate and share the knowledge for sustainable management of the shared aquifer are necessary.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Sangam Shresta	Asian Institute of Technology	Thailand	sangamshrestha@gmail.com	Regional coordinator
Chamroeun Sok	National Polytechnic Institute of Cambodia	Cambodia	Lounh2003@yahoo.com	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.

1 of the 3 TBA countries has provided information. Information was adequate to describe the aquifer in general terms. Some quantitative information was also available, and some of the indicators could be calculated 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 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:

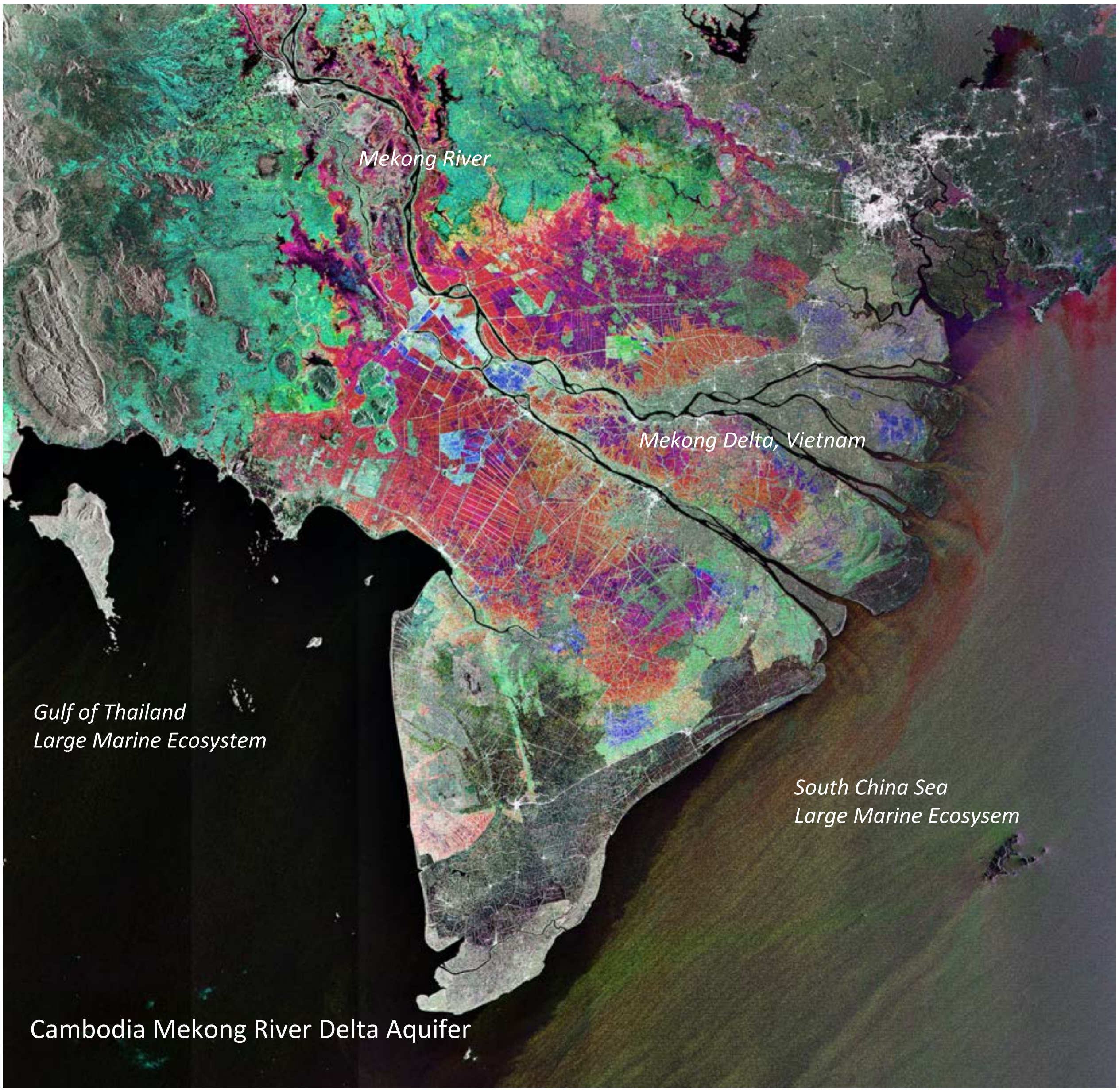
If you have additional data or information about this transboundary aquifer that can improve the quality of this information sheet and the underlying database, please contact us via email at info@un-igrac.org. If appropriate, the information will be uploaded to the database of transboundary aquifers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

AS89 - Cambodia Mekong River Delta Aquifer

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



ESA

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

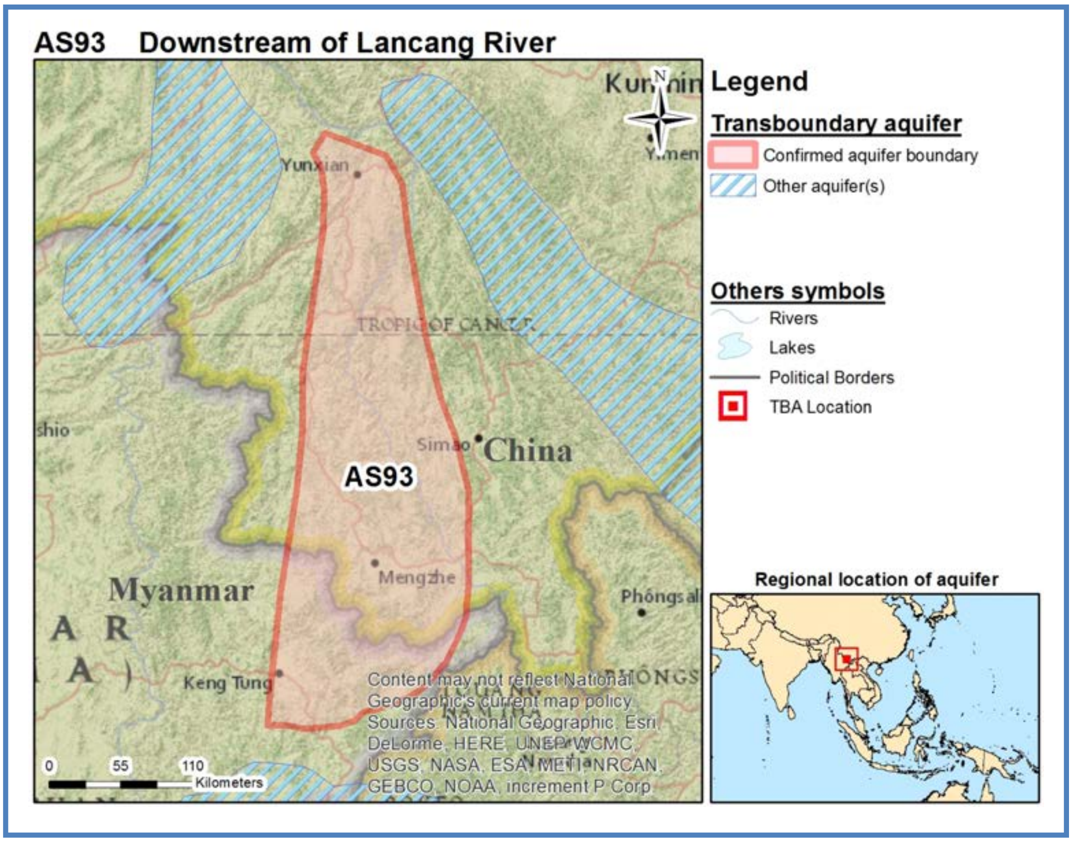
Rainfall (mm/yr): 1400

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**

Key parameters table from Global Inventory

AS93 - Downstream of Lancang River

	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
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 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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AS93 - Downstream of Lancang River

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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

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

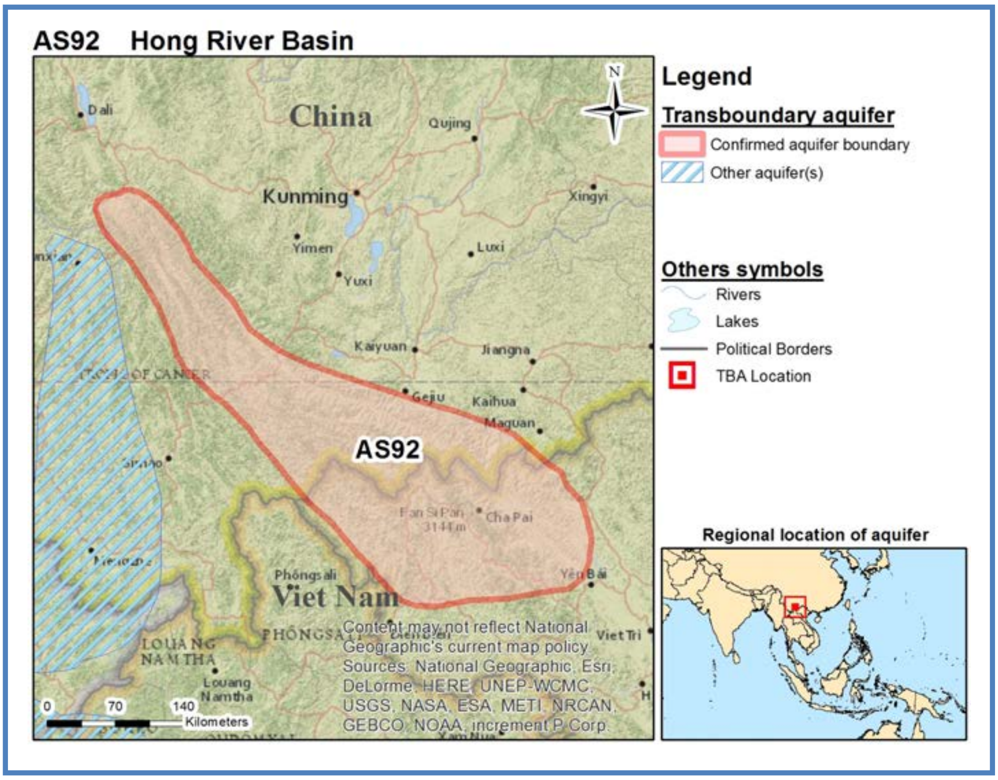
Rainfall (mm/yr): 1500

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

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

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.

AS92 - Hong River Basin

Environmental aspects

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

AS92 - Hong River Basin

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: May 2017

AS119 - Karst Aquifer of Upper Zuojiang Valley

Geography

Total area TBA (km²): 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.

AS119 - Karst Aquifer of Upper Zuojiang Valley

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 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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- 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

AS90 - Khorat Plateau Aquifer

Geography

Total area TBA (km^2): 100 000

No. countries sharing: 2

Countries sharing: Laos, Thailand

Population: 15 000 000

Climate Zone: Tropical Dry

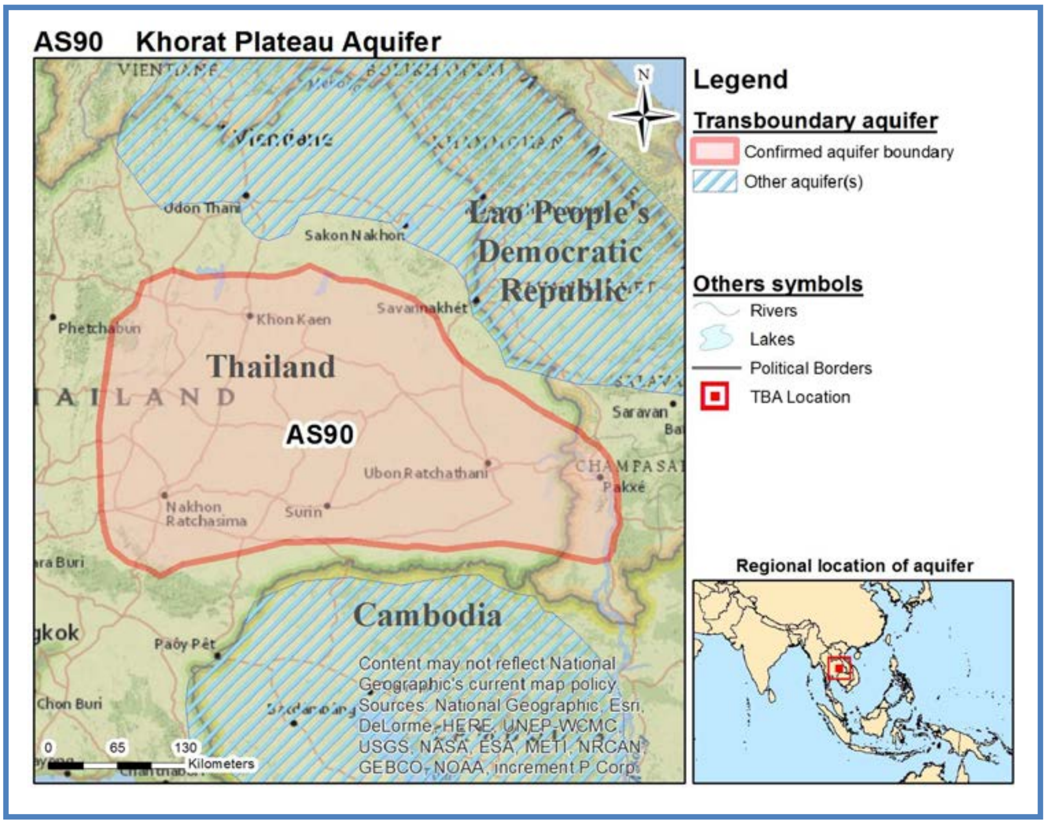
Rainfall (mm/yr): 1400

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

AS90 - Khorat Plateau Aquifer

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(%)
Lao People's Democratic Republic	410	5600	-31	-41	1	3	1	3
Thailand	250	1600	-15	-14	5	22	2	6
TBA level	**260**	**1700**	**-15**	**-15**	**5**	**22**	**2**	**6**

	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)
Lao People's Democratic Republic	1	74	35	60	<1	0	0
Thailand	-1	150	9	10	1	1	2
TBA level	**-1**	**150**	**10**	**11**	**1**	**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:
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.

AS90 - Khorat Plateau Aquifer

Colophon

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- All other data: TWAP Groundwater (2015).

Version: October 2015

AS151 – Limbang Aquifer

Geography

Total area TBA (km^2): 6300

No. countries sharing: 2

Countries sharing: Malaysia, Brunei Darussalam

Population: 180 000

Climate Zone: Tropical Wet

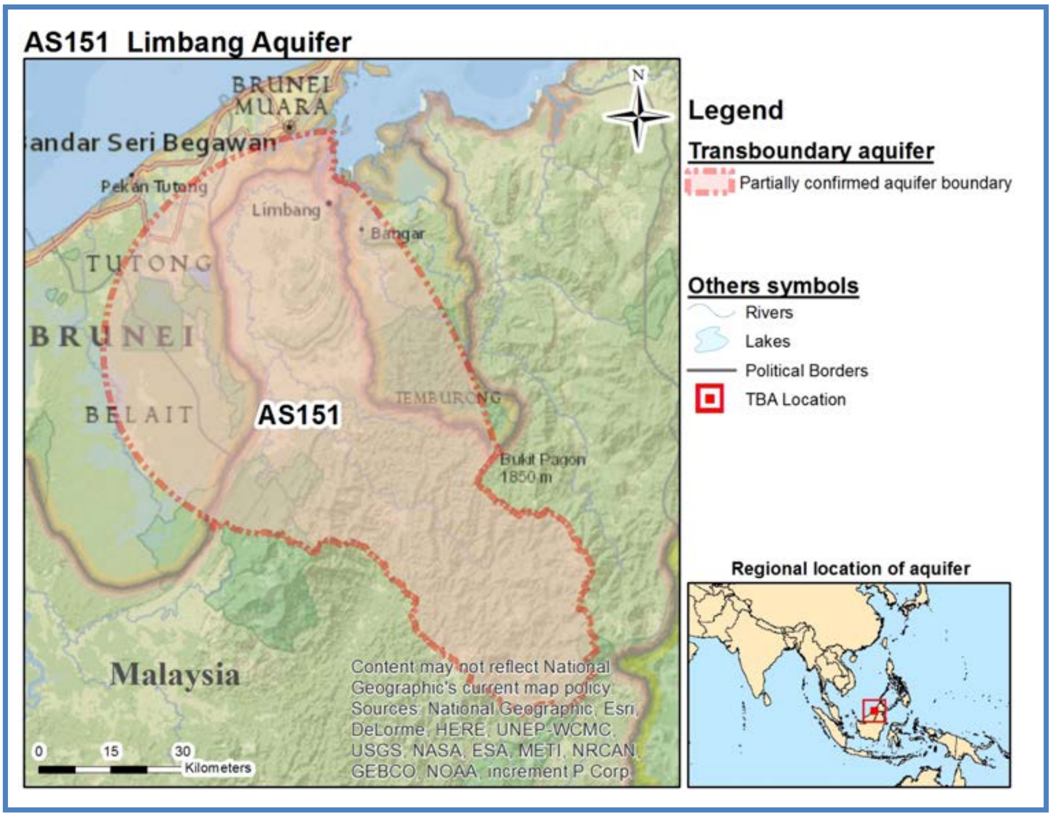
Rainfall (mm/yr): 3400

Hydrogeology

Aquifer type: Single layered

Degree of confinement: Unconfined

Main Lithology: Sediment - Sand



No Cross-section Provided

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

AS151 – Limbang 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)
Brunei Darussalam							42			
Malaysia							22		D	E
TBA level							**29**			

(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)
Brunei Darussalam								
Malaysia	<5			Unconfined	Sediment - Sand	High primary porosity fine/ medium sedimentary deposits	Secondary porosity: Weathering	
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.

AS151 – Limbang Aquifer

Aquifer description

Aquifer geometry
This aquifer is single layered system that is unconfined. The average depth to the water table is less than 5 m (Malaysia).

Hydrogeological aspects
The predominant aquifer lithology is sediment – sand that has a high primary porosity with secondary porosity: due to weathering. The formation is also characterised by a low horizontal and vertical connectivity. No data is available on the average transmissivity value, on the groundwater volume, and on the amount of recharge that occurs, as well as on the long-term trend of the water levels with regard to groundwater depletion.

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 generally suitable for human consumption, except for a few isolated localities where an increase in the natural salinity levels occurs but the data is not available to determine the percentage of the aquifer area that has been affected. Some anthropogenic groundwater pollution over a significant part of the aquifer has been identified/ suspected but the data is not available to determine the percentage of the aquifer area that has been affected. The main causes are through landfills/ waste disposal sites, households, municipalities, industrial waste disposal, and agricultural practices. This has resulted in salinisation, higher nitrate levels, excess hydrocarbons, pathogens, pesticides, heavy metals, and industrial organic compounds Within the Malaysia part of the system <5 % of the aquifer is characterised by shallow groundwater whereas 50 % of the aquifer area is covered with groundwater dependent ecosystems.

Socio-economic aspects
No data is available on the total amount of groundwater that was abstracted from the system nor on the total amount of freshwater that was abstracted over the aquifer area.

Legal and Institutional aspects
No Transboundary Agreement exists, nor is one under preparation. Furthermore no institution exists for TBA management.

Emerging Issues
Legal and institutional support is needed in order to introduce Transboundary cooperation and to promote joint groundwater control and management mechanisms.

AS151 – Limbang Aquifer

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Sangam Shresta	Asian Institute of Technology	Thailand	sangamshrestha@gmail.com	Regional coordinator
Mohd Khairul Nizar	National Hydraulic research Institute of Malaysia	Malaysia	nizar.nahrim@1govuc.gov.my	Contributing national expert
Ismail Tawnie	National Hydraulic Research Institute of Malaysia	Malaysia	ismail@nahrim.gov.my	Contributing national expert
Saim Suratman	National hydraulic Research Institute of Malaysia	Malaysia	saim@nahrim.gov.my	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 1 of the 2 TBA countries have provided information. This information did not allow for an adequate description of this aquifer system. Although some quantitative information was available, it was not enough to calculate indicators with.

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.

AS151 – Limbang Aquifer

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

AS118 - Lower Mekong River 1 Aquifer

Geography

Total area TBA (km^2): 32 000

No. countries sharing: Laos, Myanmar, Thailand

Countries sharing: 3

Population: 2 700 000

Climate Zone: Tropical Dry

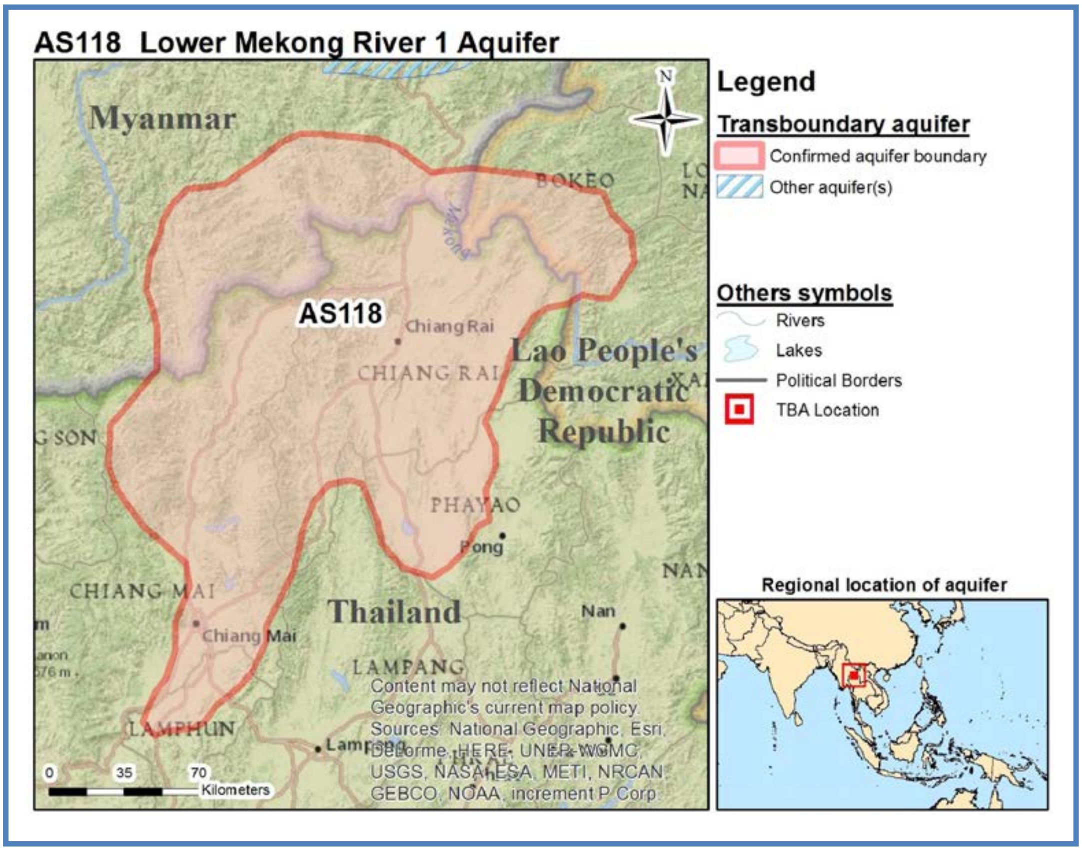
Rainfall (mm/yr): 1400

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.

AS118 - Lower Mekong River 1 Aquifer

TWAP Groundwater Indicators from Global Inventory

No data available.

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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- All other data: TWAP Groundwater (2015).

Version: October 2015

AS91 - Lower Mekong River 2 Aquifer

Geography

Total area TBA (km^2): 110 000

No. countries sharing: 2

Countries sharing: Laos, Thailand, Vietnam

Population: 7 200 000

Climate Zone: Humid Subtropical

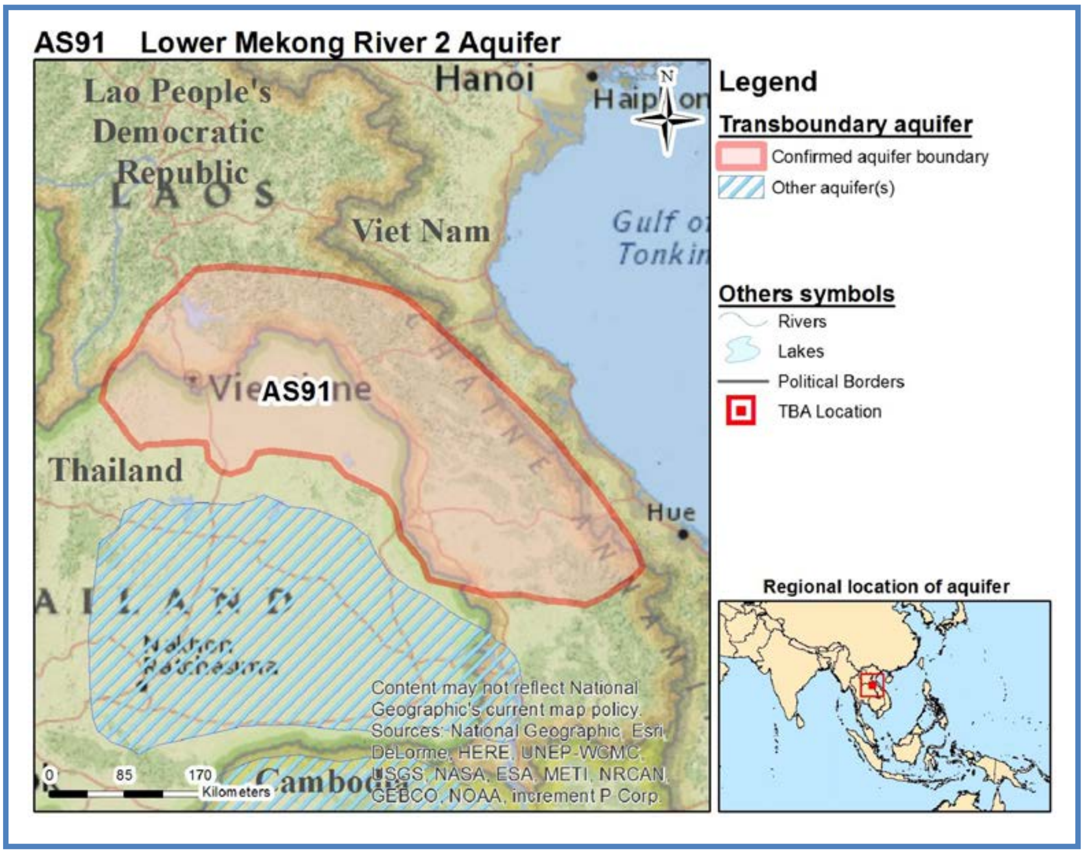
Rainfall (mm/yr): 2 100

Hydrogeology

Aquifer type: Data not available

Degree of confinement: Data not available

Main Lithology: Data not available



No cross-section available

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AS91 - Lower Mekong River 2 Aquifer

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)				
Lao People's Democratic Republic	350	8700	-29	-38	3	11	1	3
Thailand	360	2900	-19	-20	7	22	2	9
Viet Nam	200	5500	-20	-24	1	3	0	2
TBA level	**350**	**5300**	**-23**	**-28**	**5**	**17**	**2**	**5**

	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)
Lao People's Democratic Republic	2	40	31	51	<1	0	0
Thailand	2	130	13	17	1	1	1
Viet Nam	0	37	22	32	<1	0	0
TBA level	**2**	**66**	**20**	**31**	**<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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AS91 - Lower Mekong River 2 Aquifer

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- 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

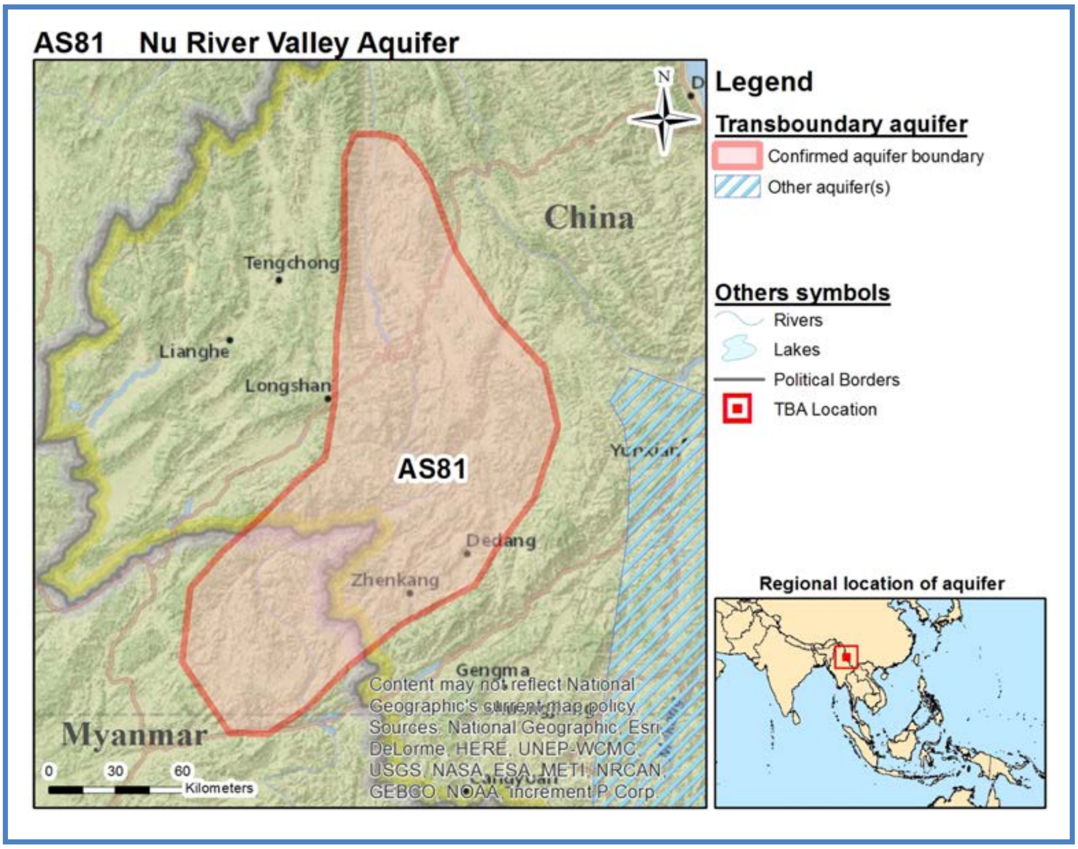
Rainfall (mm/yr): 1300

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
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

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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Version: May 2017

AS82 - Salween River Aquifer

Geography

Total area TBA (km^2): 34 000

No. countries sharing: 2

Countries sharing: Myanmar, Thailand

Population: 1 100 000

Climate Zone: Tropical Wet

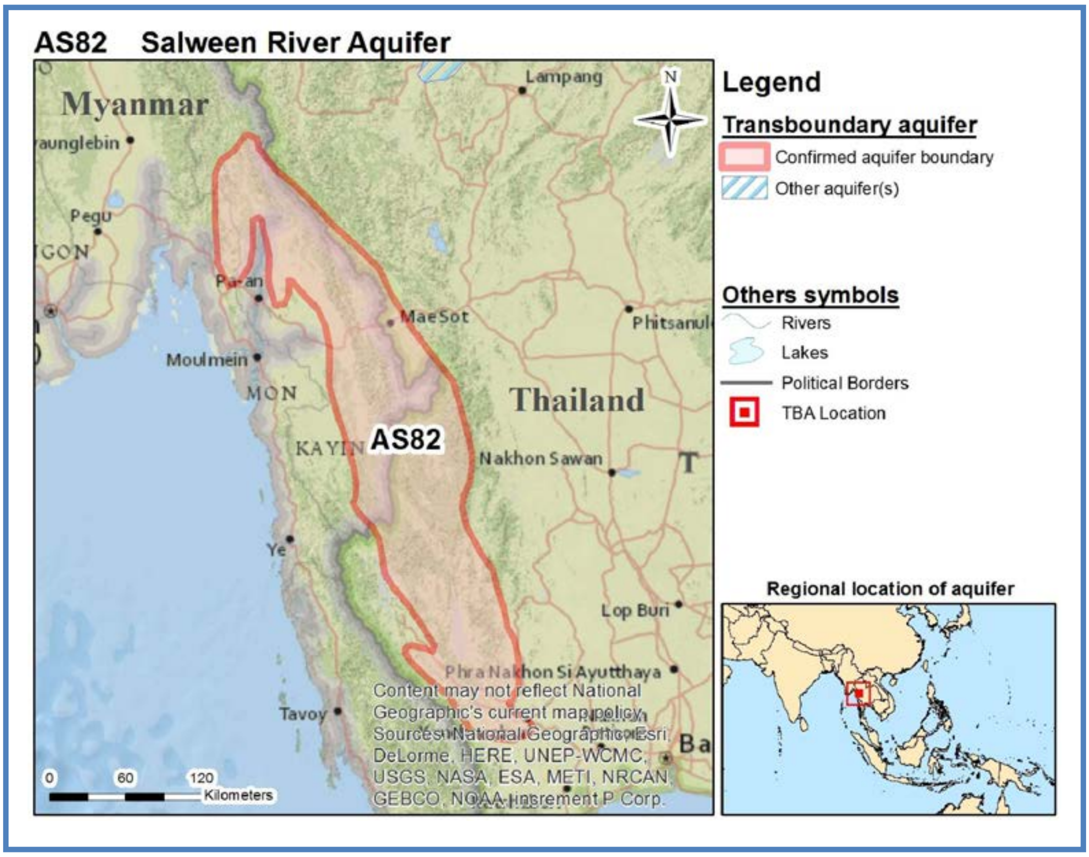
Rainfall (mm/yr): 2000

Hydrogeology

Aquifer type: Data not available

Degree of confinement: Data not available

Main Lithology: Data not available



No cross-section available

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AS82 - Salween River Aquifer

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)				
Myanmar	410	8400	-16	-19	5	22	3	6
Thailand	220	8000	-11	-11	4	22	2	0
TBA level	**310**	**8200**	**-14**	**-16**	**4**	**22**	**2**	**1**

	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)
Myanmar	0	49	16	21	<1	0	0
Thailand	0	27	10	11	<1	0	0
TBA level	**0**	**37**	**14**	**17**	<1	**0**	**0**

Key parameters table from Global Inventory

No data available.

Aquifer description

No data available.

Contributors to Global Inventory

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AS82 - Salween River Aquifer

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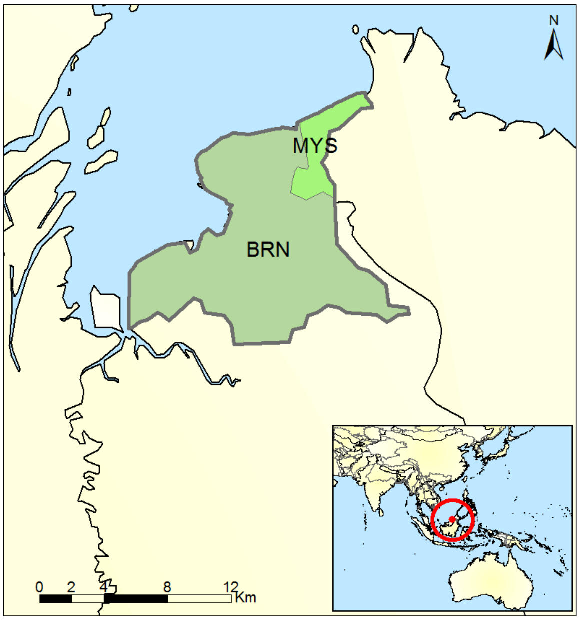
Version: December 2015

1. Bangau
2. Bei Jiang Hsi
3. Beilun
4. Ca/ Song-Koi
5. Digul
6. Fly
7. Ganges-Brahmaputra-Meghna
8. Golok
9. Irrawaddy
10. Jayapura
11. Kaladan
12. Karnaphuli
13. Loes
14. Ma
15. Maro
16. Mekong
17. Pakchan
18. Red/ Song Hong
19. Saigon
20. Salween
21. Sebuku
22. Sembakung
23. Sepik
24. Song Vam Co Dong
25. Tami
26. Tjeroaka-Wanggoe
27. Vanimo-Green

United Nations Educational, Scientific and Cultural Organization · International Hydrological Programme
igrac International Groundwater Resources Assessment Centre
Goethe Universität Frankfurt am Main
SFU Simon Fraser University Engaging the World

Bangau Basin



Geography

Total drainage area (km^2)	130
No. of countries in basin	2
BCUs in basin	Brunei Darussalam (BRN), Malaysia (MYS)
Population in basin (people)	1,495
Country at mouth	Brunei Darussalam
Average rainfall (mm/year)	

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)
BNGU_BRN						
BNGU_MYS						
Total in Basin					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 (%)
BNGU_BRN								
BNGU_MYS								

[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								

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)
BNGU _BRN	0	0.90	1	11.19	1.88			0	38,563.31	0	0.00
BNGU _MYS	0	0.10	0	14.33	1.69			0	10,513.71	0	0.00
Total in Basin	0	1.00	1	11.50	1.37	0.00	0.00	0	35,171.56	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**
BNGU_BRN					4	5			3	5	3		1	1	1
BNGU_MYS					5	5			3	5	3	3	1	2	5
River Basin				2	4				3	5	3		1	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

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**
BNGU_BRN									3
BNGU_MYS									3
River Basin					2	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					

[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

Disclaimer

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Bei Jiang/Hsi Basin

Geography

Total drainage area (km²)	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 (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)
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 (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 (%)
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 (km²)	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 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)
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

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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
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.

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

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Ca/Song-Koi Basin

Geography

Total drainage area (km^2)	27,246
No. of countries in basin	2
BCUs in basin	Lao People'S Democratic Republic (LAO), Viet Nam (VNM)
Population in basin (people)	2,740,642
Country at mouth	Viet Nam
Average rainfall (mm/year)	1,732

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)
CAXX_LAO		670.75				
CAXX_VNM		812.06				
Total in Basin	20.73	760.83			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 (%)
CAXX_LAO	21.94	14.92	1.56	0.00	0	5.04	128.72	
CAXX_VNM	1,582.66	552.74	10.58	12.40	366	640.83	615.78	

[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	1,604.60	567.66	12.13	12.40	366.54	645.87	585.48	7.74

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)
CAXX_LAO	9	0.34	170	18.29	1.50			0	1,645.74	0	0.00
CAXX_VNM	18	0.66	2,570	143.37	1.10	0.00	100.00	1	1,910.53	0	0.00
Total in Basin	27	1.00	2,741	100.59	1.10	0.00	93.78	1	1,894.07	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
CAXX_LAO	1	1	2		5	1	2	5	3	5	3	3	1	3	2
CAXX_VNM	2	2	2		5	2	2	5	3	4	5	5	1	2	5
River Basin	2	1	2	3	5	2	2	5	2	4	5	5	1	3	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
CAXX_LAO	2	2	1	1			2	3	3
CAXX_VNM	3	3	2	2			1	2	5
River Basin	3	3	2	2	3	3	1	2	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				

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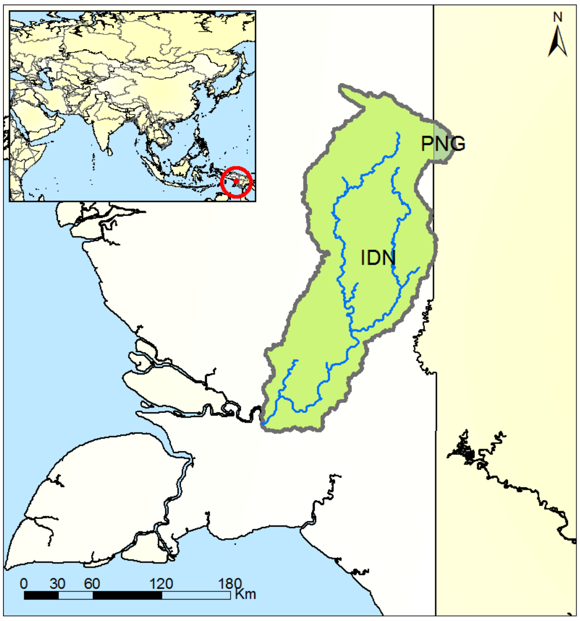
Digul Basin



Geography

Total drainage area (km^2)	25,484
No. of countries in basin	2
BCUs in basin	Indonesia (IDN), Papua New Guinea (PNG)
Population in basin (people)	65,143
Country at mouth	XXX
Average rainfall (mm/year)	3,732

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	2
Large Marine Ecosystems	0

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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)
DIGL_IDN		2,723.86				
DIGL_PNG						
Total in Basin	69.42	2,723.86			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 (%)
DIGL_IDN	8.82	0.32	0.14	3.24	0	5.12	137.93	
DIGL_PNG								

[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	8.82	0.32	0.14	3.24	0.00	5.12	135.36	0.01

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)
DIGL_IDN	25	0.98	64	2.56				0	3,475.25	0	0.00
DIGL_PNG	1	0.02	1	2.38				0	2,088.35	0	0.00
Total in Basin	25	1.00	65	2.56	1.23	0.00	0.00	0	3,449.45	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**
DIGL_IDN	1	1	1		5	5	1	3	1	5	3	3	1	3	3
DIGL_PNG					5	1			1	5	3		1	3	1
River Basin	1	1	1	2	5	5	1	4	1	5	3	3	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**
DIGL_IDN	2	2	1	1					3
DIGL_PNG									3
River Basin	2	2	1	1	2	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	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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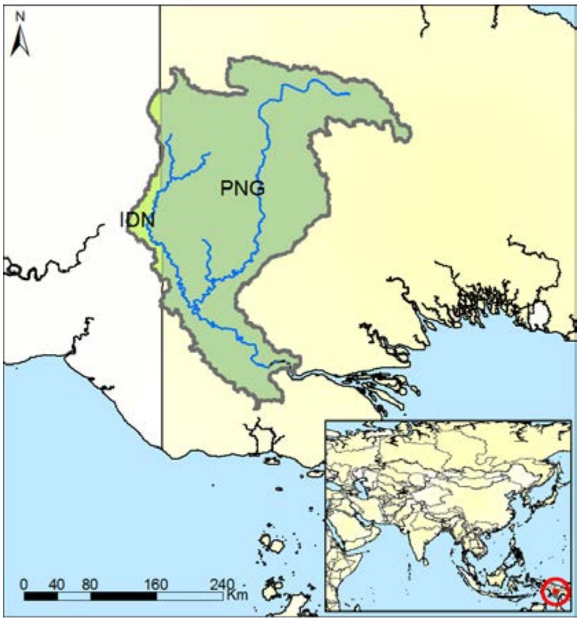
Fly Basin



Geography

Total drainage area (km^2)	63,886
No. of countries in basin	2
BCUs in basin	Indonesia (IDN), Papua New Guinea (PNG)
Population in basin (people)	349,358
Country at mouth	Papua New Guinea
Average rainfall (mm/year)	3,476

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	3
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)
FLYX_IDN		2,142.01				
FLYX_PNG		2,563.17			782.00	4.07
Total in Basin	162.82	2,548.65			782.00	4.07

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 (%)
FLYX_IDN	0.30	0.00	0.01	0.00	0	0.30	56.56	
FLYX_PNG	25.32	0.00	0.56	13.47	0	11.28	73.60	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
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Total in Basin	25.62	0.00	0.57	13.47	0.00	11.58	73.33	0.02

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)
FLYX_IDN	3	0.04	5	2.07	1.08			0	3,475.25	0	0.00
FLYX_PNG	61	0.96	344	5.61	2.36	0.00	100.00	0	2,088.35	0	0.00
Total in Basin	64	1.00	349	5.47	2.12	0.00	98.46	0	2,109.69	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
FLYX_IDN	1	1	1		5	5	1	3	1	4	2	3	1	3	2
FLYX_PNG	1	1	1		5	4	1	3	1	4	2		1	3	2
River Basin	1	1	1	2	5	5	1	3	1	4	2		1	4	2

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
FLYX_IDN	2	2	1	1			1	2	2
FLYX_PNG	2	2	1	1			2	4	2
River Basin	2	2	1	1	2	2	2	4	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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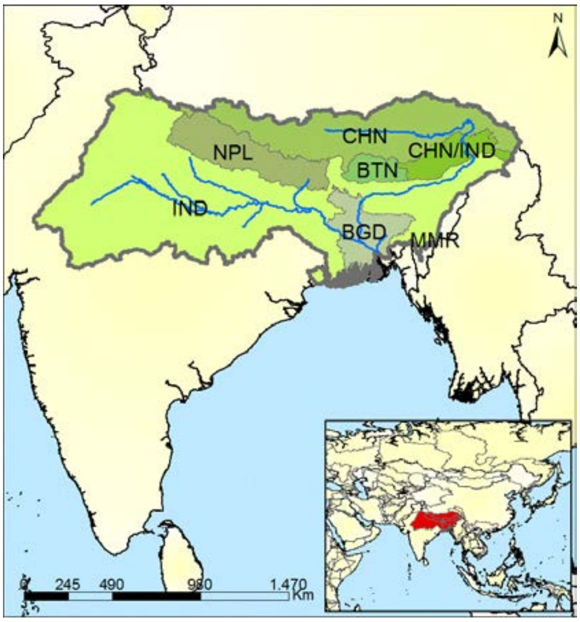
Ganges-Brahmaputra-Meghna Basin



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/
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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 (%)
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 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)
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

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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**
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

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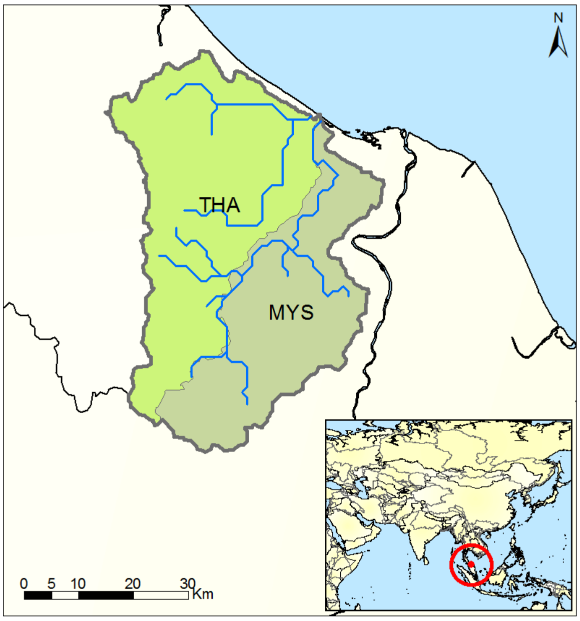
Golok Basin



Geography

Total drainage area (km^2)	2,320
No. of countries in basin	2
BCUs in basin	Malaysia (MYS), Thailand (THA)
Population in basin (people)	489,877
Country at mouth	Malaysia, Thailand
Average rainfall (mm/year)	2,727

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

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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)
GLOK_MYS		1,630.76				
GLOK_THA		1,146.70				
Total in Basin	3.03	1,308.10			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 (%)
GLOK_MYS	291.23	236.63	0.48	0.00	14	39.71	1,487.93	
GLOK_THA	408.14	349.97	1.74	0.00	17	39.04	1,387.52	

[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	699.37	586.60	2.22	0.00	31.80	78.75	1,427.64	23.05

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)
GLOK_MYS	1	0.43	196	197.86	1.69			0	10,513.71	0	0.00
GLOK_THA	1	0.57	294	221.10	0.71	0.00	100.00	0	5,778.98	0	0.00
Total in Basin	2	1.00	490	211.19	0.85	0.00	60.05	0	7,670.69	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
GLOK_MYS	1		2		5	3			3	5	3	3	4	2	4
GLOK_THA	2		2		5	4			3	5	3	3	1	2	2
River Basin	2		2	2	5				2	5	3	3	2	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
GLOK_MYS	2	3							3
GLOK_THA	3	3							3
River Basin	3	3			4	4			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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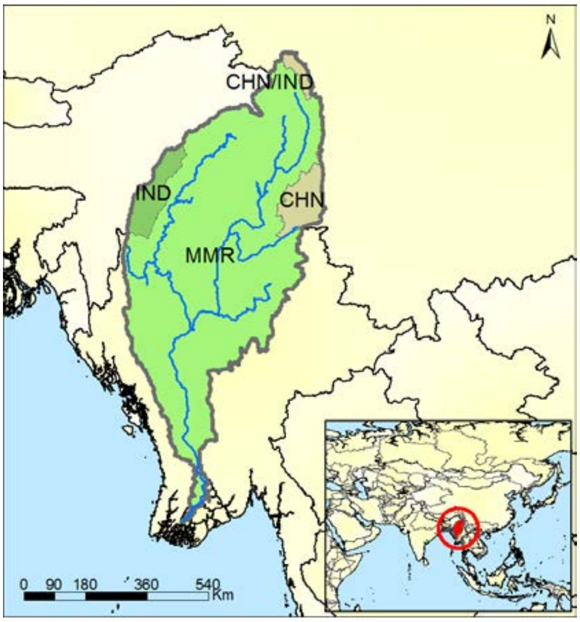
Irrawaddy Basin



Geography

Total drainage area (km²)	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 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)
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

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
IRWD_CHN	1	1	2		5	1	4	2	2	5	5	2	1	3	2
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

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

[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/IND									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

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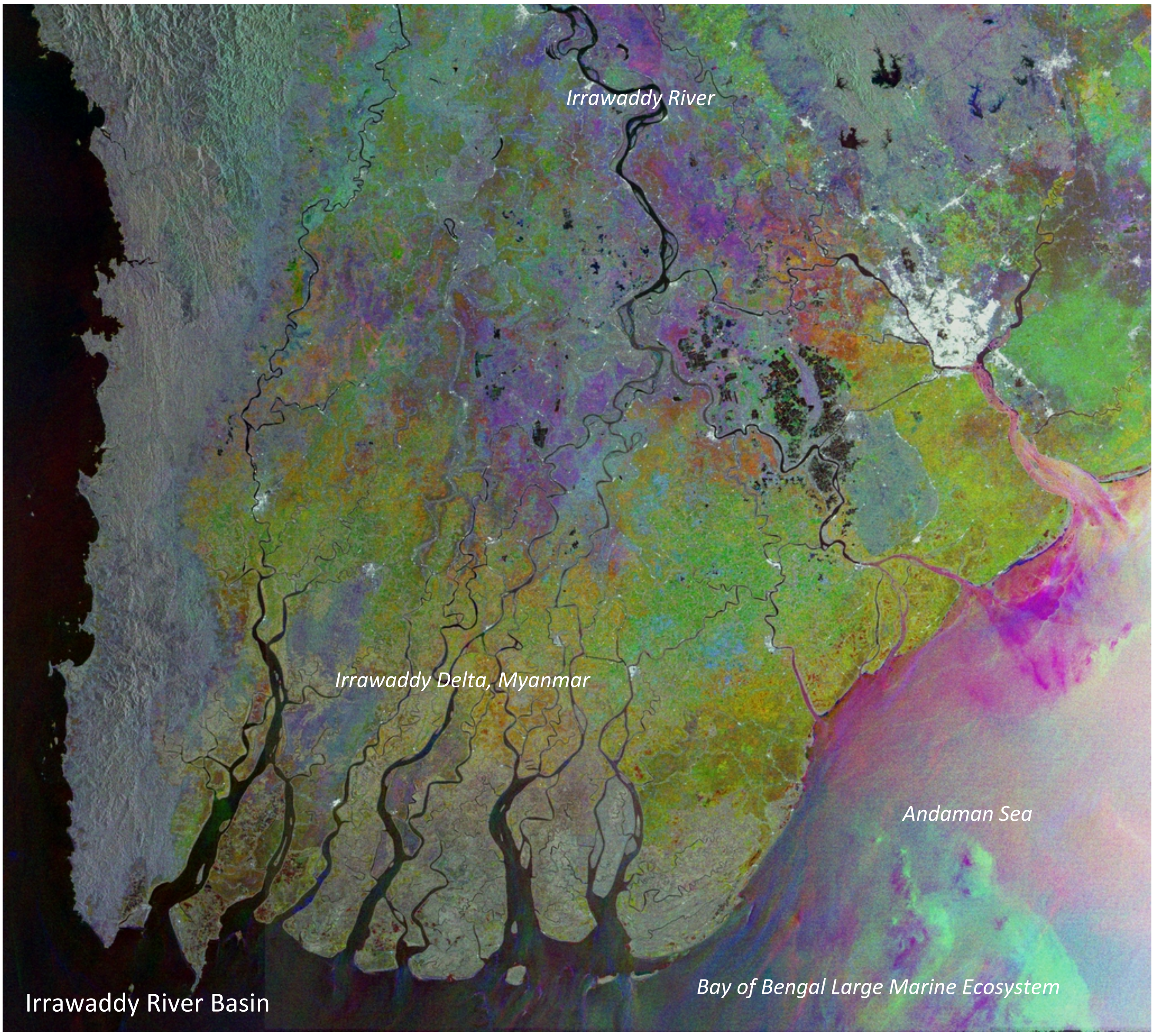
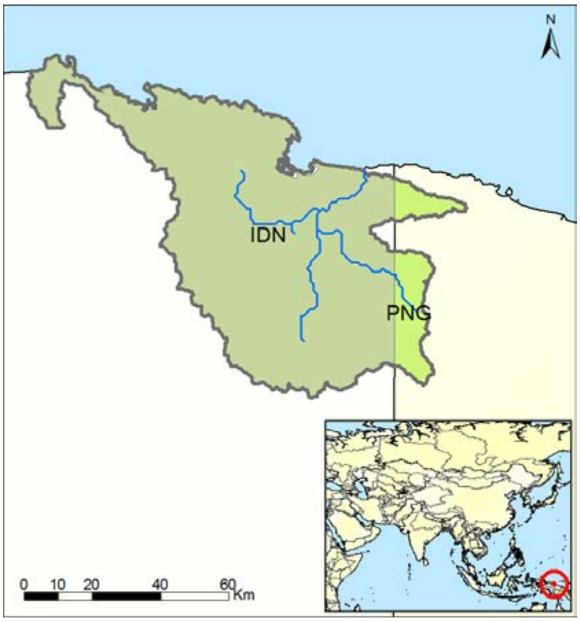


ESA

Jayapura Basin



Geography

Total drainage area (km^2)	5,253
No. of countries in basin	2
BCUs in basin	Indonesia (IDN), Papua New Guinea (PNG)
Population in basin (people)	328,736
Country at mouth	XXX
Average rainfall (mm/year)	2,151

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	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)
JAPR_IDN		738.36			100.70	0.62
JAPR_PNG						
Total in Basin	3.88	738.36			100.70	0.62

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 (%)
JAPR_IDN	14.66	0.16	0.11	1.79	0	12.60	45.01	
JAPR_PNG								

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Total in Basin	14.66	0.16	0.11	1.79	0.00	12.60	44.60	0.38

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)
JAPR_IDN	5	0.91	326	68.35		0.00	100.00	1	3,475.25	0	0.00
JAPR_PNG	0	0.09	3	6.18				0	2,088.35	0	0.00
Total in Basin	5	1.00	329	62.58	1.22	0.00	99.08	1	3,462.52	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
JAPR_IDN	1	1	1		5		2	3	1	5	3	3	1	3	2
JAPR_PNG					5				1	5	3		1	3	1
River Basin	1	1	1	2	5		1	3	1	5	3	3	1	3	2

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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
JAPR_IDN	1	2	1	1					3
JAPR_PNG									3
River Basin	1	2	1	1	2	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	2				

[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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Kaladan Basin

Geography

Total drainage area (km²)	21,391
No. of countries in basin	3
BCUs in basin	Bangladesh (BGD), India (IND), Myanmar (MMR)
Population in basin (people)	628,332
Country at mouth	Myanmar
Average rainfall (mm/year)	3,085

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	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)
KALD_BGD						
KALD_IND		2,260.02				
KALD_MMR		2,114.98				
Total in Basin	46.27	2,163.03			0.00	0.00

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 (%)
KALD_BGD								

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KALD_IND	49.80	21.11	1.47	11.06	0	16.17	145.43	
KALD_MMR	33.75	9.21	5.06	0.00	2	17.55	118.16	
Total in Basin	83.55	30.31	6.52	11.06	1.93	33.72	132.96	0.18

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)
KALD_BGD	0	0.00	0	22.81				0	829.25	0	0.00
KALD_IND	8	0.38	342	41.82	1.43	0.00	100.00	0	1,498.87	0	0.00
KALD_MMR	13	0.62	286	21.65	0.70			0	0.00	0	0.00
Total in Basin	21	1.00	628	29.37	1.07	0.00	54.50	0	817.22	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**
KALD_BGD					5				1	5	3	2	1	3	1
KALD_IND	1	1	2		5		3	3	1	5	3	1	1	3	2
KALD_MMR	1	1	2		5	1	2	3	1	5	3	4	1	3	3
River Basin	1	1	2	3	5	1	2	3	1	5	3	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
KALD_BGD									4
KALD_IND	2	3	1	1			1	2	3
KALD_MMR	2	3	1	1			1	1	3
River Basin	2	3	1	1	3	4	1	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	1				

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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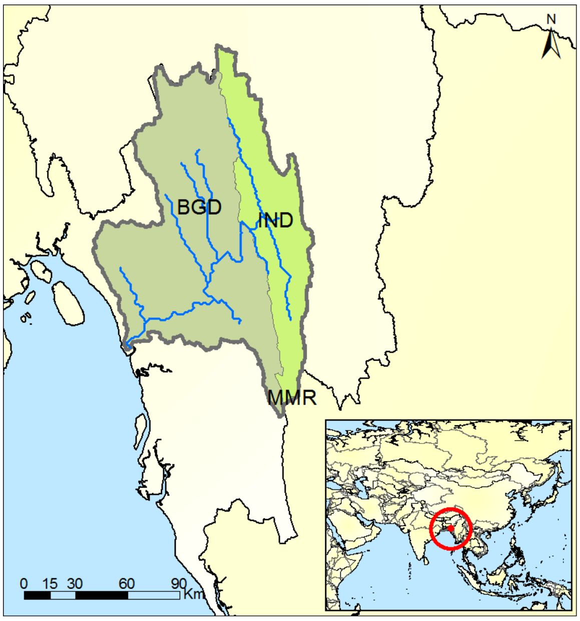
Karnaphuli Basin



Geography

Total drainage area (km^2)	13,923
No. of countries in basin	3
BCUs in basin	Bangladesh (BGD), India (IND), Myanmar (MMR)
Population in basin (people)	6,233,894
Country at mouth	Bangladesh
Average rainfall (mm/year)	2,816

Governance

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

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)
KNFL_BGD		1,611.92			490.80	13.80
KNFL_IND						
KNFL_MMR						
Total in Basin	22.44	1,611.92			490.80	13.80

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 (%)
KNFL_BGD	2,936.50	2,393.20	17.11	241.52	62	222.90	481.62	

[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/

UNEP gef UNEP-DHI PARTNERSHIP Centre on Water and Environment UNEP DHI

KNFL_IND								
KNFL_MMR								
Total in Basin	2,936.50	2,393.20	17.11	241.52	61.77	222.90	471.05	13.08

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)
KNFL_ BGD	10	0.71	6,097	621.13	1.12	0.00	100.00	1	829.25	1	101.87
KNFL_I ND	4	0.29	136	33.30	1.43	0.00	100.00	0	1,498.87	0	0.00
KNFL_ MMR	0	0.00	0	32.86	0.70			0	0.00	0	0.00
Total in Basin	14	1.00	6,234	447.73	1.22	0.00	99.99	1	843.83	1	71.82

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**
KNFL_BGD	3	1	2		5	1	3	3	2	5	2	2	1	3	4
KNFL_IND		1			5		3	3	2	5	2	1	1	3	2
KNFL_MMR					5				1	5	3	4	1	3	1
River Basin	4	1	2	2	5	1	3	3	2	5	2	2	1	3	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**
KNFL_BGD	4	4	1	2			2	2	3
KNFL_IND			1	1			1	2	2
KNFL_MMR									3
River Basin	4	5	1	1	4	4	2	2	3

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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	2				

Indicators

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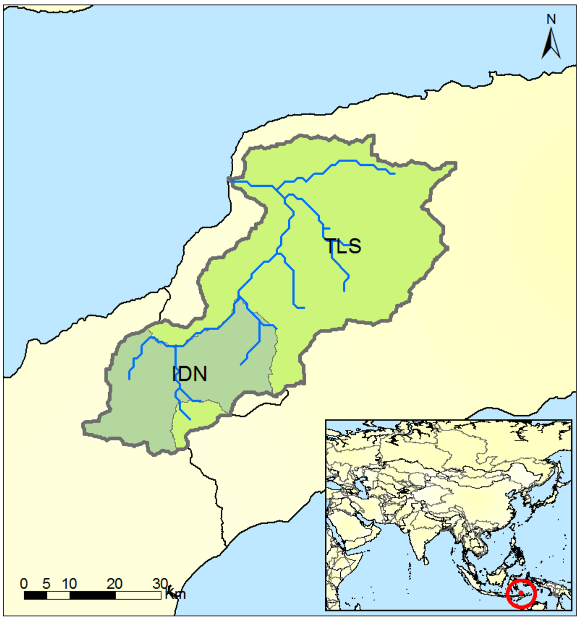
Loes Basin



Geography

Total drainage area (km^2)	2,567
No. of countries in basin	2
BCUs in basin	Indonesia (IDN), Timor-Leste (TLS)
Population in basin (people)	186,375
Country at mouth	Timor-Leste
Average rainfall (mm/year)	1,416

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	3

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)
LOES_IDN						
LOES_TLS		282.63				
Total in Basin	0.73	282.63			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 (%)
LOES_IDN								
LOES_TLS	2,112.34	94.63	4.47	2,000.78	0	12.47	21,179.74	

[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	2,112.34	94.63	4.47	2,000.78	0.00	12.47	11,333.84	291.19

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)
LOES_IDN	1	0.28	87	122.10	1.08			0	3,475.25	0	0.00
LOES_TLS	2	0.72	100	53.71	2.14	0.00	100.00	0	1,370.67	0	0.00
Total in Basin	3	1.00	186	72.62	1.91	0.00	53.51	0	2,349.04	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
LOES_IDN					5				1	5	3	3	1	3	1
LOES_TLS	2	2	2		5		2		1	5	3	5	4	4	3
River Basin	2	2	2	3	5		2		1	5	3	5	3	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
LOES_IDN									3
LOES_TLS	3	4	3	4					3
River Basin	3	4	3	4	4	4			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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Ma Basin

Geography

Total drainage area (km^2)	29,512
No. of countries in basin	2
BCUs in basin	Lao People'S Democratic Republic (LAO), Viet Nam (VNM)
Population in basin (people)	2,984,577
Country at mouth	Viet Nam
Average rainfall (mm/year)	1,646

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	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)
MAXX_LAO		647.07				
MAXX_VNM		820.84				
Total in Basin	22.51	762.90			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 (%)
MAXX_LAO	86.53	50.24	1.68	0.00	17	17.70	288.23	
MAXX_VNM	2,013.13	538.39	11.45	1.13	675	787.56	749.95	

[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	2,099.66	588.63	13.12	1.13	691.53	805.26	703.50	9.33

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)
MAXX_LAO	13	0.43	300	23.84	1.50	0.00	100.00	0	1,645.74	0	0.00
MAXX_VNM	17	0.57	2,684	158.65	1.10			0	1,910.53	0	0.00
Total in Basin	30	1.00	2,985	101.13	1.13	0.00	10.06	0	1,883.90	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
MAXX_LAO	1	1	2		5	1	2	4	2	5	5	3	1	3	3
MAXX_VNM	2	2	2		5	2	2	5	2	4	5	5	1	3	4
River Basin	2	2	2	5	5	1	2	5	2	4	5	4	1	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
MAXX_LAO	2	2	1	1			2	3	5
MAXX_VNM	3	3	3	3			1	2	5
River Basin	2	3	2	2	4	5	1	2	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				

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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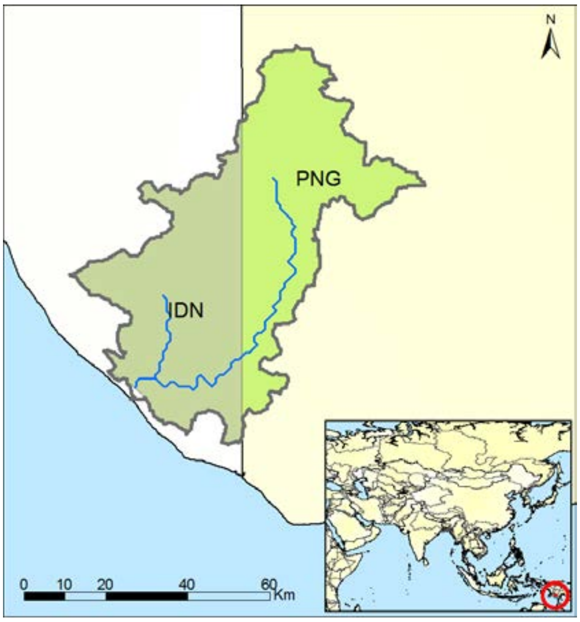
Maro Basin



Geography

Total drainage area (km^2)	3,319
No. of countries in basin	2
BCUs in basin	Indonesia (IDN), Papua New Guinea (PNG)
Population in basin (people)	6,672
Country at mouth	XXX
Average rainfall (mm/year)	1,761

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)
MARO_IDN		999.97				
MARO_PNG		1,212.86				
Total in Basin	3.67	1,106.42			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 (%)
MARO_IDN	18.61	16.33	0.04	0.00	0	2.25	4,973.72	
MARO_PNG	0.31	0.19	0.01	0.00	0	0.11	106.37	

[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	18.93	16.52	0.05	0.00	0.00	2.36	2,836.77	0.52

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)
MARO_IDN	2	0.50	4	2.25				0	3,475.25	0	0.00
MARO_PNG	2	0.50	3	1.77				0	2,088.35	0	0.00
Total in Basin	3	1.00	7	2.01	1.61	0.00	0.00	0	2,866.35	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**
MARO_IDN	1		2		5	5			1	5	3	3	3	3	1
MARO_PNG	1		1		5	5			1	5	3		4	3	2
River Basin	1		2	2	5				1	5	3		3	4	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**
MARO_IDN	2	2							3
MARO_PNG	2	2							3
River Basin	2	2			2	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	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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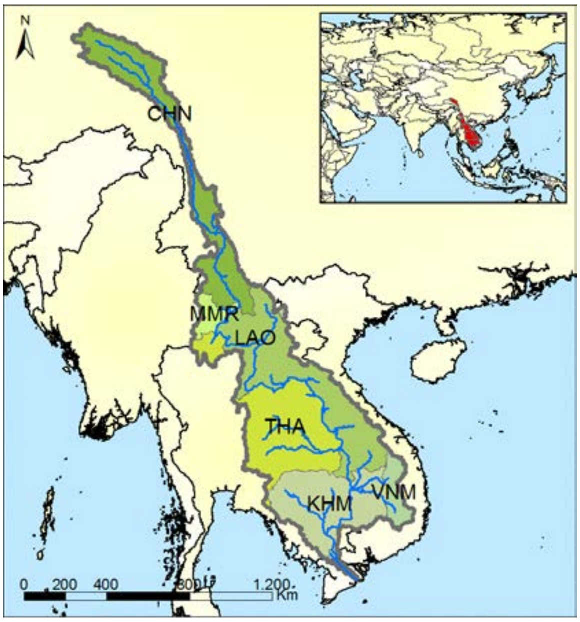
Mekong Basin



Geography

Total drainage area (km^2)	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 (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)
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

[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 (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
MEKO_THA	2	3	2		5	3	5	5	4	2	3	3	4	2	4
MEKO_VNM	2	3	2		5	1	3	5	4	1	3	5	3	3	5
River Basin	2	2	2	3	5	3	3	5	4	2	3	3	4	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.

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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
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
River Basin	3	3	2	2	4	4	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	1	5	2	4	3

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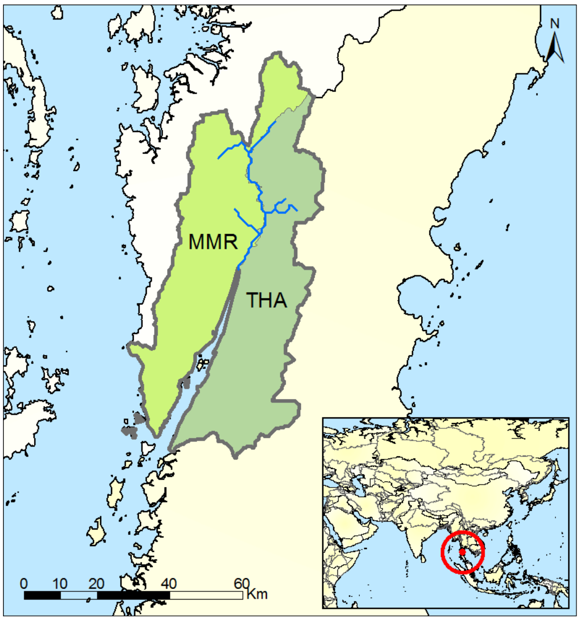
Pakchan Basin



Geography

Total drainage area (km²)	3,226
No. of countries in basin	2
BCUs in basin	Myanmar (MMR), Thailand (THA)
Population in basin (people)	134,566
Country at mouth	Myanmar, Thailand
Average rainfall (mm/year)	3,301

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 (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)
PKCN_MMR					7.55	0.04
PKCN_THA		2,030.82			14.33	0.08
Total in Basin	6.55	2,030.82			50.69	0.29

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 (%)
PKCN_MMR								
PKCN_THA	118.66	95.11	0.67	2.74	0	20.14	1,303.98	

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Total in Basin	118.66	95.11	0.67	2.74	0.00	20.14	881.78	1.81

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)
PKCN_MMR	2	0.49	44	27.58	0.70			0	0.00	0	0.00
PKCN_THA	2	0.51	91	55.28	0.71	0.00	100.00	0	5,778.98	0	0.00
Total in Basin	3	1.00	135	41.72	0.51	0.00	67.62	0	3,907.90	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
PKCN_MMR					5	2			3	5	3	4	1	3	4
PKCN_THA	1	1	2		5	2	2		3	5	3	3	1	2	3
River Basin	1	1	2	2	5	2	2		2	5	3	3	1	2	3

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PKCN_MMR							1	1	4
PKCN_THA	2	2	1	1			1	1	3
River Basin	2	2	1	1	2	2	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				

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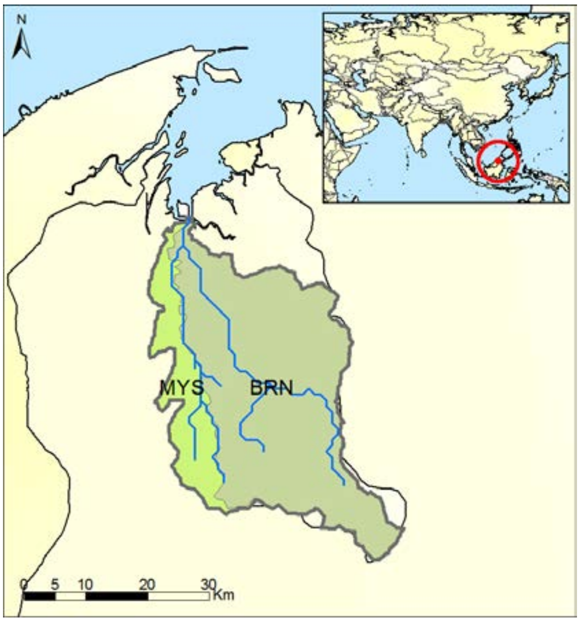
Pandaruan Basin



Geography

Total drainage area (km^2)	1,202
No. of countries in basin	2
BCUs in basin	Brunei Darussalam (BRN), Malaysia (MYS)
Population in basin (people)	13,864
Country at mouth	Brunei Darussalam
Average rainfall (mm/year)	3,804

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	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)
PNDR_BRN						
PNDR_MYS		1,984.45				
Total in Basin	2.39	1,984.45			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 (%)
PNDR_BRN								
PNDR_MYS	300.79	2.78	0.90	259.10	0	38.01	45,014.43	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
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Total in Basin	300.79	2.78	0.90	259.10	0.00	38.01	21,696.70	12.61

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)
PNDR_BRN	1	0.81	7	7.39	1.88	100.00	0.00	0	38,563.31	0	0.00
PNDR_MYS	0	0.19	7	28.91	1.69			0	10,513.71	0	0.00
Total in Basin	1	1.00	14	11.53	1.47	51.80	0.00	0	25,043.56	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
PNDR_BRN					4	3			3	5	3		1	1	2
PNDR_MYS	1		2		5	3			3	5	3	3	1	2	4
River Basin	1		2	2	4				3	5	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
PNDR_BRN									3
PNDR_MYS	2	3							3
River Basin	2	3			2	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	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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Red/Song Hong Basin

Geography

Total drainage area (km²)	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

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Saigon Basin

Geography

Total drainage area (km²)	29,643
No. of countries in basin	2
BCUs in basin	Cambodia (KHM), Viet Nam (VNM)
Population in basin (people)	10,911,289
Country at mouth	Viet Nam
Average rainfall (mm/year)	2,100

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 (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)
SAIG_KHM		1,109.80				
SAIG_VNM		1,160.86				
Total in Basin	34.32	1,157.67			0.00	0.00

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 (%)
SAIG_KHM	443.47	401.24	1.18	0.00	0	41.05	9,222.04	
SAIG_VNM	8,515.07	3,476.86	15.37	559.34	2,430	2,033.03	783.85	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
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Total in Basin	8,958.53	3,878.10	16.55	559.34	2,430.47	2,074.08	821.03	26.11

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)
SAIG_KHM	1	0.02	48	74.35	1.14			0	1,007.57	0	0.00
SAIG_VNM	29	0.98	10,863	374.65	1.10	0.00	100.00	3	1,910.53	4	137.95
Total in Basin	30	1.00	10,911	368.09	1.05	0.00	99.56	3	1,906.55	4	134.94

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
SAIG_KHM	1	1	2		5		3	5	3	5	3	2	1	3	4
SAIG_VNM	2	2	2		5	2	4	4	3	4	5	5	3	2	5
River Basin	2	2	2	4	5	2	4	5	2	4	5	5	3	3	5

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
SAIG_KHM	2	2	1	1					3
SAIG_VNM	2	2	3	3			1	2	5
River Basin	2	2	3	3	4	5	1	2	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				

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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/
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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 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)
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

[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				

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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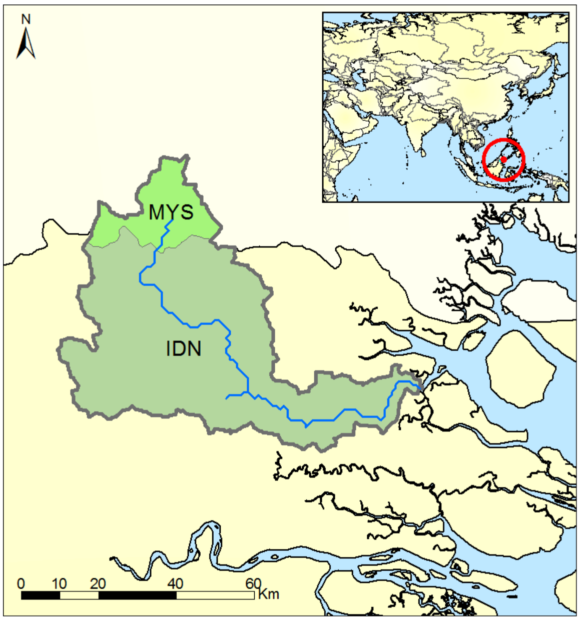
Sebuku Basin



Geography

Total drainage area (km^2)	3,070
No. of countries in basin	2
BCUs in basin	Indonesia (IDN), Malaysia (MYS)
Population in basin (people)	15,505
Country at mouth	XXX
Average rainfall (mm/year)	2,588

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	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)
SBKU_IDN		1,061.92				
SBKU_MYS						
Total in Basin	3.26	1,061.92			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 (%)
SBKU_IDN	4.86	0.00	0.01	0.00	0	4.85	356.71	
SBKU_MYS								

[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	4.86	0.00	0.01	0.00	0.00	4.85	313.44	0.15

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)
SBKU_IDN	3	0.87	14	5.11				0	3,475.25	0	0.00
SBKU_MYS	0	0.13	2	4.63				0	10,513.71	0	0.00
Total in Basin	3	1.00	16	5.05	1.26	0.00	0.00	0	4,328.97	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**
SBKU_IDN	1	1	1		5	3	1		3	5	3	3	1	2	3
SBKU_MYS					5				3	5	3	3	1	2	1
River Basin	1	1	1	2	5	3	1		3	5	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**
SBKU_IDN	2	2	1	1					3
SBKU_MYS									3
River Basin	2	3	1	1	2	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	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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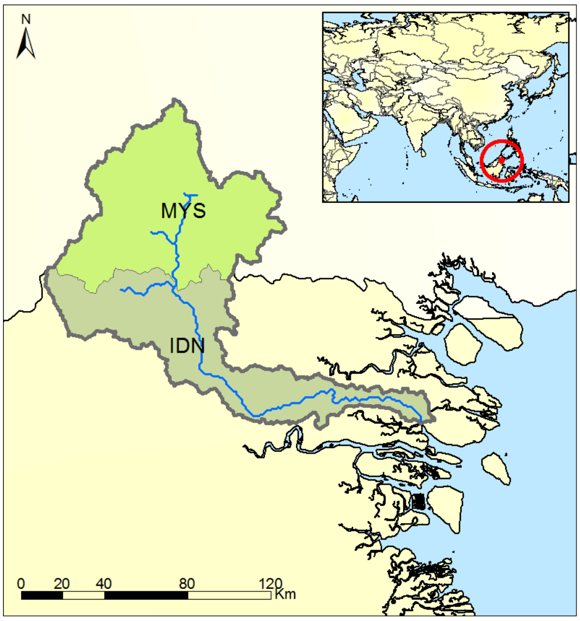
Sembakung Basin



Geography

Total drainage area (km^2)	10,253
No. of countries in basin	2
BCUs in basin	Indonesia (IDN), Malaysia (MYS)
Population in basin (people)	52,056
Country at mouth	Indonesia
Average rainfall (mm/year)	2,781

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)
SMBK_IDN		1,458.15				
SMBK_MYS		1,238.93				
Total in Basin	13.60	1,326.69			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 (%)
SMBK_IDN	13.92	11.22	0.02	0.00	0	2.68	1,332.08	
SMBK_MYS	53.59	19.50	0.15	0.07	1	33.13	1,288.03	

[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	67.51	30.72	0.17	0.07	0.74	35.81	1,296.87	0.50

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)
SMBK_IDN	5	0.47	10	2.17	1.08			0	3,475.25	0	0.00
SMBK_MYS	5	0.53	42	7.66	1.69			0	10,513.71	0	0.00
Total in Basin	10	1.00	52	5.08	1.54	0.00	0.00	0	9,100.97	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
SMBK_IDN	1	1	2		5	3	1	2	3	5	3	3	2	2	4
SMBK_MYS	1	1	2		5		2	2	3	5	3	3	1	2	2
River Basin	1	1	2	2	5	2	1	3	3	5	3	3	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
SMBK_IDN	2	3	1	1			1	2	3
SMBK_MYS	2	2	1	1			2	3	3
River Basin	2	3	1	1	2	2	2	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	1				

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Indicators

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Sepik Basin

Geography

Total drainage area (km^2)	79,778
No. of countries in basin	2
BCUs in basin	Indonesia (IDN), Papua New Guinea (PNG)
Population in basin (people)	970,816
Country at mouth	Papua New Guinea
Average rainfall (mm/year)	2,963

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)
SEPK_IDN		5,805.71				
SEPK_PNG		1,684.61			177.30	0.53
Total in Basin	144.06	1,805.78			177.30	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 (%)
SEPK_IDN	0.96	0.06	0.03	0.00	0	0.88	47.70	
SEPK_PNG	37.22	0.00	1.42	3.54	2	30.22	39.15	

[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	38.18	0.06	1.45	3.54	2.04	31.10	39.32	0.03

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)
SEPK_IDN	3	0.04	20	5.83	1.08			0	3,475.25	0	0.00
SEPK_PNG	76	0.96	951	12.46	2.36	0.00	100.00	0	2,088.35	0	0.00
Total in Basin	80	1.00	971	12.17	2.11	0.00	97.92	0	2,117.15	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
SEPK_IDN	1	1	1		5	4	1	4	1	4	3	3	1	3	2
SEPK_PNG	1	1	1		5	4	1	3	1	4	3		1	3	2
River Basin	1	1	1	2	5	4	1	4	1	4	3		1	4	2

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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
SEPK_IDN	2	2	1	1					3
SEPK_PNG	2	2	1	1			2	4	3
River Basin	2	2	1	1	2	2	2	4	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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Song Vam Co Dong Basin

Geography

Total drainage area (km^2)	15,526
No. of countries in basin	2
BCUs in basin	Cambodia (KHM), Viet Nam (VNM)
Population in basin (people)	5,171,971
Country at mouth	Viet Nam
Average rainfall (mm/year)	1,540

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)
SVCD_KHM		661.74				
SVCD_VNM		526.62				
Total in Basin	8.77	565.13			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 (%)
SVCD_KHM	245.35	215.85	3.97	0.00	3	22.95	139.51	
SVCD_VNM	9,308.83	6,801.69	7.94	263.86	1,087	1,148.22	2,727.24	

[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	9,554.18	7,017.53	11.91	263.86	1,089.70	1,171.17	1,847.30	108.89

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)
SVCD_KHM	7	0.43	1,759	263.28	1.14	0.00	100.00	0	1,007.57	0	0.00
SVCD_VNM	9	0.57	3,413	385.87	1.10	0.00	100.00	0	1,910.53	0	0.00
Total in Basin	16	1.00	5,172	333.12	1.31	0.00	100.00	0	1,603.48	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**
SVCD_KHM	1	5	2		5	3	4	5	3	5	3	2	1	4	5
SVCD_VNM	2	5	5		5	5	3	5	3	4	3	5	2	2	5
River Basin	2	5	4	4	5	5	3	5	2	4	3	3	2	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
SVCD_KHM	2	2	5	5			2	3	3
SVCD_VNM	2	2	5	5			1	2	3
River Basin	2	2	5	5	4	4	2	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	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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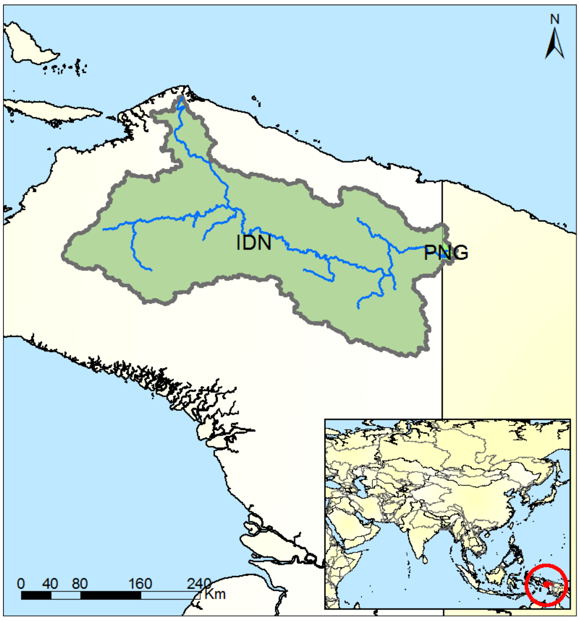
Tami Basin



Geography

Total drainage area (km^2)	78,667
No. of countries in basin	2
BCUs in basin	Indonesia (IDN), Papua New Guinea (PNG)
Population in basin (people)	535,821
Country at mouth	Indonesia
Average rainfall (mm/year)	2,841

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	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)
TAMI_IDN		1,801.52			134.10	1.38
TAMI_PNG						
Total in Basin	141.72	1,801.52			134.10	1.38

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 (%)
TAMI_IDN	48.25	0.83	0.85	2.71	0	43.86	90.55	
TAMI_PNG								

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
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Total in Basin	48.25	0.83	0.85	2.71	0.00	43.86	90.06	0.03

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)
TAMI_IDN	78	0.99	533	6.81	1.08			0	3,475.25	0	0.00
TAMI_PNG	0	0.01	3	6.19	2.36			0	2,088.35	0	0.00
Total in Basin	79	1.00	536	6.81	1.21	0.00	0.00	0	3,467.66	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**
TAMI_IDN	1	1	1		5	4	2	3	1	5	3	3	1	3	2
TAMI_PNG					5	2			1	5	3		1	3	1
River Basin	1	1	1	2	5	4	2	3	1	5	3	3	1	3	2

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
TAMI_IDN	2	2	1	1			1	2	3
TAMI_PNG									3
River Basin	2	2	1	1	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	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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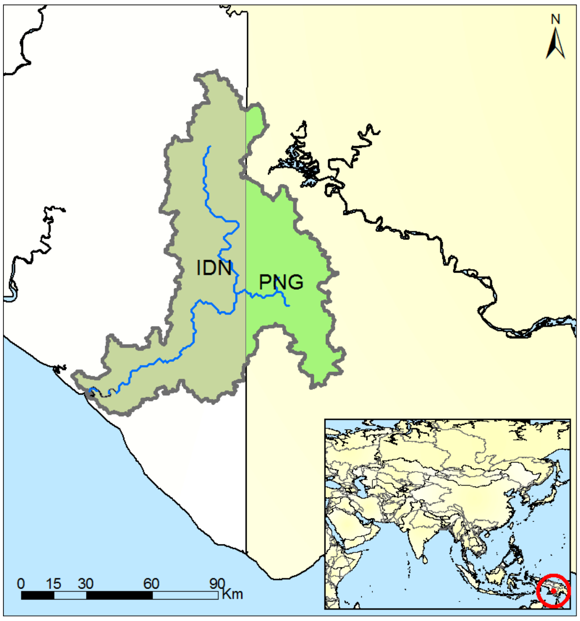
Tjeroaka-Wanggoe Basin



Geography

Total drainage area (km^2)	8,049
No. of countries in basin	2
BCUs in basin	Indonesia (IDN), Papua New Guinea (PNG)
Population in basin (people)	60,982
Country at mouth	Indonesia
Average rainfall (mm/year)	2,066

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)
TJWA_IDN		916.89				
TJWA_PNG		1,155.35				
Total in Basin	7.76	964.55			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 (%)
TJWA_IDN	6.02	1.24	0.10	0.00	0	4.68	106.80	
TJWA_PNG	0.12	0.00	0.01	0.00	0	0.11	25.91	

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Total in Basin	6.14	1.24	0.11	0.00	0.00	4.79	100.66	0.08

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)
TJWA_IDN	5	0.68	56	10.36	1.08			0	3,475.25	0	0.00
TJWA_PNG	3	0.32	5	1.77	2.36			0	2,088.35	0	0.00
Total in Basin	8	1.00	61	7.58	1.28	0.00	0.00	0	3,369.99	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
TJWA_IDN	1	1	1		5	4	1	2	1	5	3	3	1	3	2
TJWA_PNG	1	1	1		5	5	1	2	1	5	3		1	3	2
River Basin	1	1	1	2	5	5	1	2	1	5	3		1	4	2

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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
TJWA_IDN	2	2	1	1			1	2	3
TJWA_PNG	2	2	1	1			2	4	3
River Basin	2	2	1	1	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	1				

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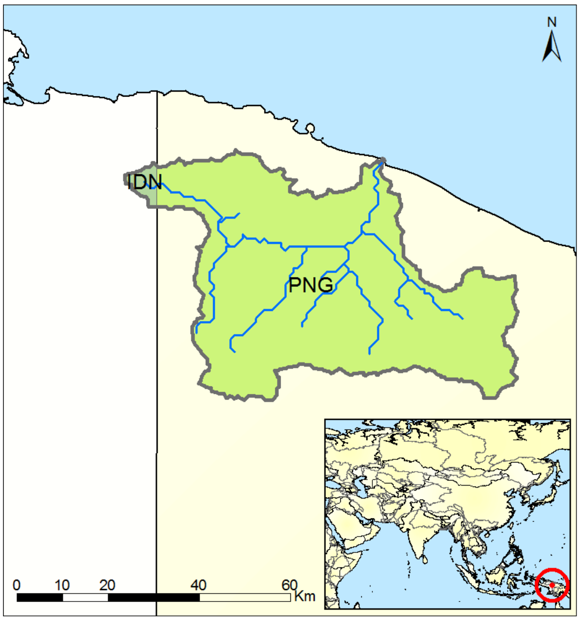
Vanimo-Green Basin



Geography

Total drainage area (km^2)	2,670
No. of countries in basin	2
BCUs in basin	Indonesia (IDN), Papua New Guinea (PNG)
Population in basin (people)	16,208
Country at mouth	XXX
Average rainfall (mm/year)	2,442

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	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)
VAGR_IDN						
VAGR_PNG		860.41				
Total in Basin	2.30	860.41			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 (%)
VAGR_IDN								
VAGR_PNG	1.20	0.00	0.04	0.50	0	0.67	74.49	

[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	1.20	0.00	0.04	0.50	0.00	0.67	73.99	0.05

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)
VAGR_IDN	0	0.01	0	2.79				0	3,475.25	0	0.00
VAGR_PNG	3	0.99	16	6.12				0	2,088.35	0	0.00
Total in Basin	3	1.00	16	6.07	2.12	0.00	0.00	0	2,097.75	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**
VAGR_IDN					5				1	5	3	3	1	3	1
VAGR_PNG	1		1		5				1	5	3		1	3	2
River Basin	1		1	2	5				1	5	3		1	4	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
VAGR_IDN									3
VAGR_PNG	2	2							3
River Basin	2	2			2	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	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

Disclaimer

The results and information of factsheet is produced and maintained by the River Basins Component of the GEF Transboundary Water Assessment Programme (GEF TWAP).

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 .

The TWAP River Basins component (TWAP RB) carried out a global comparison of 286 transboundary river basins, in order to enable the prioritisation of funds for basins at risk from a variety of issues, covering water quantity, water quality, ecosystems, governance and socio-economics. It also considered risks to deltas from threats of a transboundary nature, and considered the relative influence of lakes on these river basins. TWAP RB is an indicator–based assessment, allowing for an analysis of basins, based on risks to both societies and ecosystems. It also includes provisional outlook projections to 2030 and 2050 for a limited number of indicators.
Values given in the present fact-sheet represent an approximate guide only and should not replace recent local assessments.

Country Boundaries Under TWAP
TWAP RB assessment uses country delineations provided by FAO GAUL (Global Administrative Unit Layers) (FAO 2014). GAUL uses the International Boundary dataset of the UNCS (UN Cartographic Section) and inland boundaries are same for both datasets. Some differences occur in coastlines, where FAO GAUL dataset offers more detail.

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.

Basin Delineation
TWAP RB assessment includes 286 transboundary river basins. Information on this layer and delineation methodology can be retrieved by downloading metadata sheet for the Basins layer from TWAP Rivers Data Portal at http://twap-rivers.org/indicators/ or by direct download from http://twap-rivers.org/assets/Basin%20and%20BCU%20Creation%20Documentation.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 . 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.

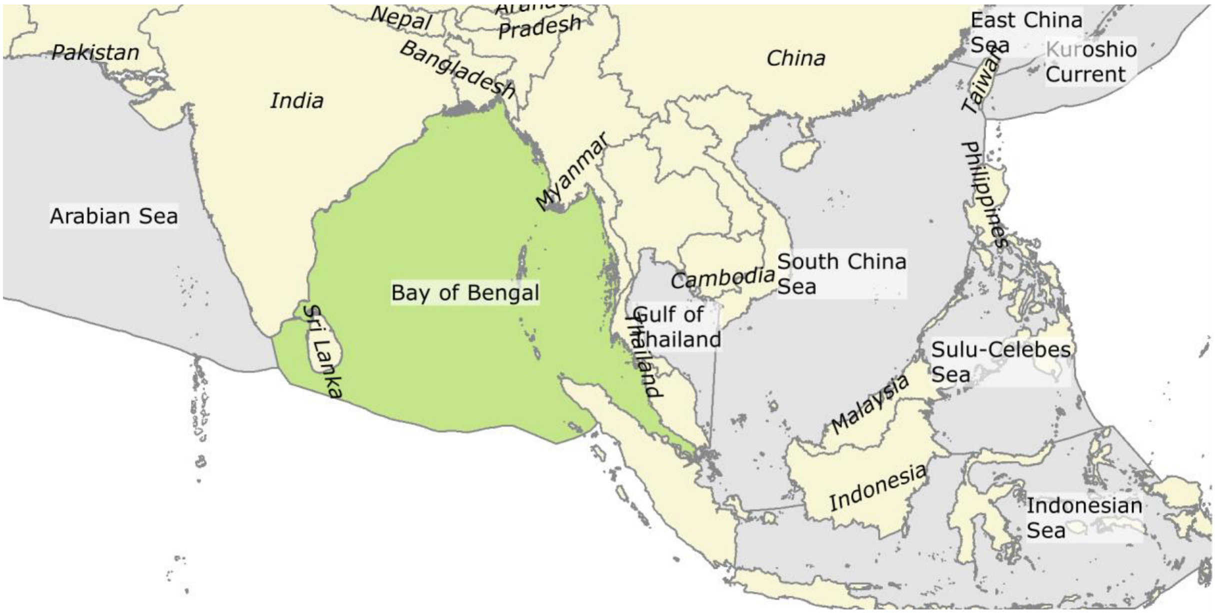
For more information on data sources, indicator calculation methodologies, limitations and more consult indicator metadata sheets available on TWAP RB Data portal on http://twap-rivers.org .

Large Marine Ecosystems of Southeastern Asia

1. LME 34 – Bay of Bengal
2. LME 35 – Gulf of Thailand
3. LME 36 – South China Sea
4. LME 37 – Sulu-Celebes Sea
5. LME 38 – Indonesian Sea

Jesse Allen, NASA , using Landsat data from U. Maryland Global Land Cover Facility & Karen Seto (Stanford U.)

LME 34 – Bay of Bengal



Bordering countries: Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka, Thailand.
LME Total area: 3,657,502 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.

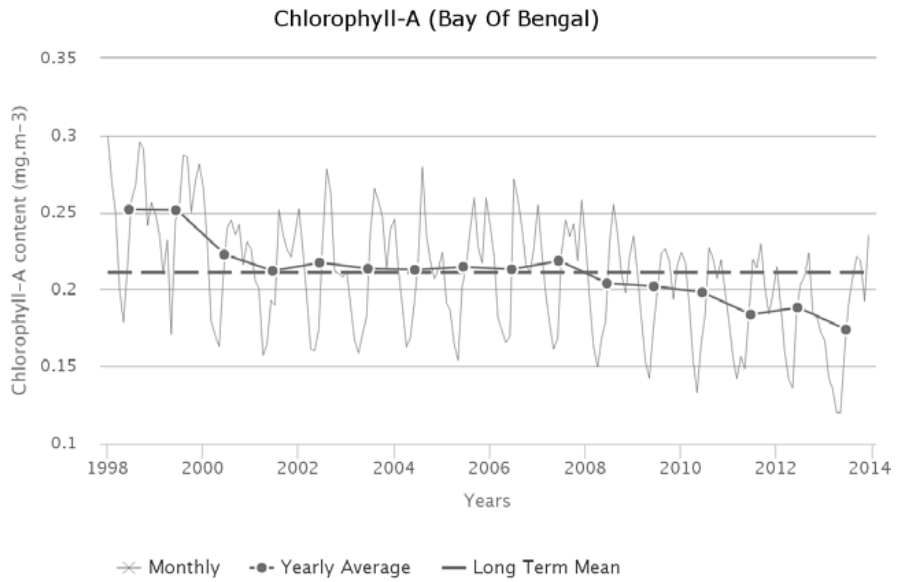
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very high.

Very low | Low | Medium | High | Very high

Productivity

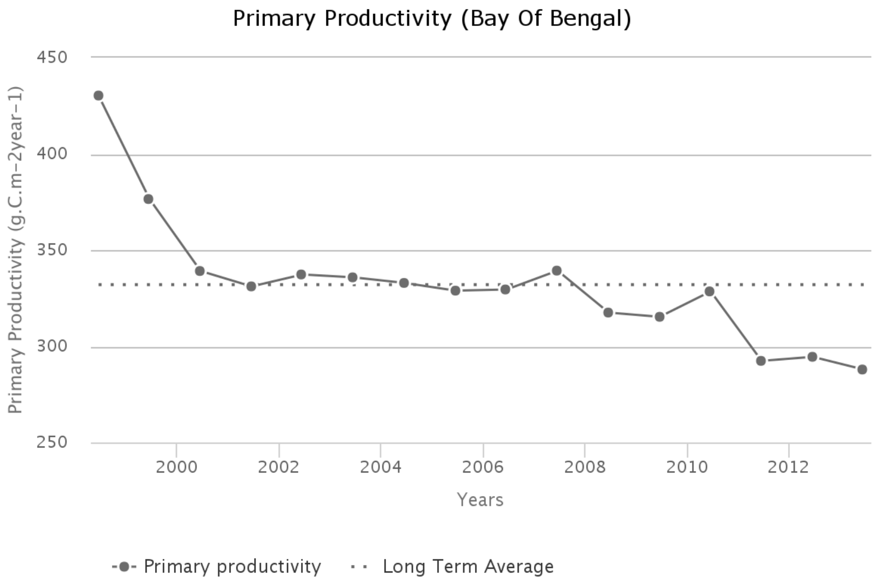
Chlorophyll-A

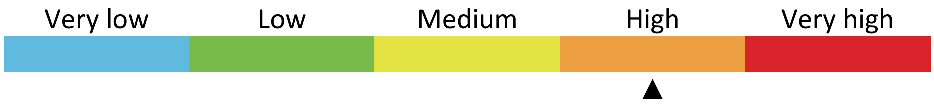
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.253 $mg.m^{-3}$) in August and a minimum (0.162 $mg.m^{-3}$) during May. The average CHL is 0.211 $mg.m^{-3}$. Maximum primary productivity (430 $g.C.m^{-2}.y^{-1}$) occurred during 1998 and minimum primary productivity (288 $g.C.m^{-2}.y^{-1}$) during 2013. There is a statistically insignificant decreasing trend in Chlorophyll of -5.76 % from 2003 through 2013. The average primary productivity is 332 $g.C.m^{-2}.y^{-1}$, which places this LME in Group 4 of 5 categories (with 1 = lowest and 5= highest).



Very low | Low | Medium | High | Very high

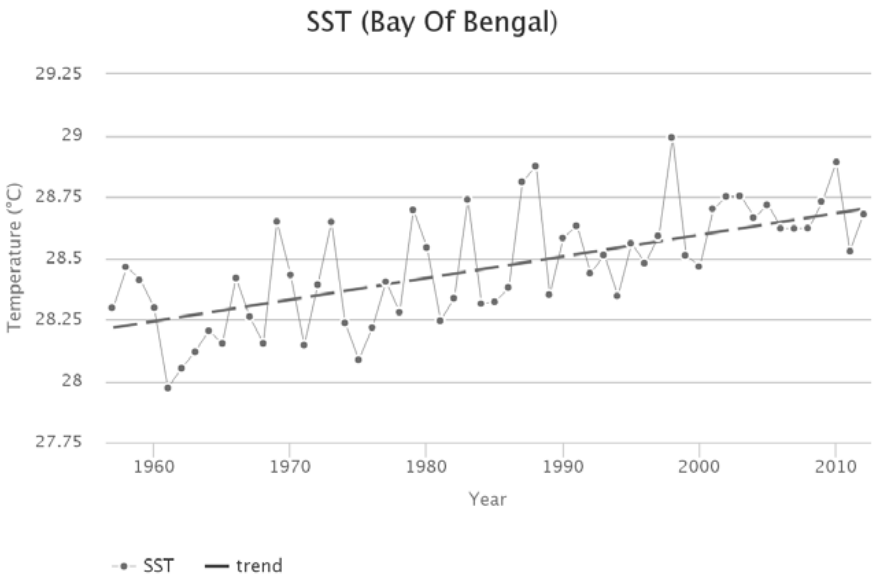
Primary productivity





Sea Surface Temperature

From 1957 to 2012, the Bay of Bengal LME #34 has warmed by 0.53°C, thus belonging to Category 3 (moderate warming LME). The steady warming of the Bay of Bengal was modulated by interannual (every 3-to-5 years) variations with a typical magnitude of <0.5°C. The all-time maximum of 1998 occurred simultaneously with other Indian Ocean LMEs and could be linked to the El Niño 1997-1998. Temperature history of the Bay of Bengal is linked to its salinity regime and freshwater discharge of three great rivers, Ganges, Brahmaputra and Irrawaddy. Interannual variability of the Indian monsoon largely determines the river discharge, hence salinity regime and eventually SST variability, in the Bay of Bengal LME.

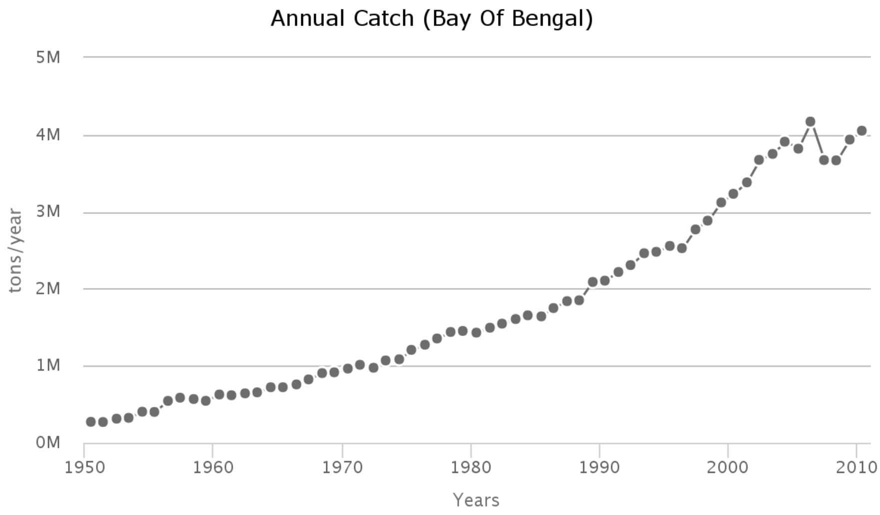


Fish and Fisheries

The fisheries of the Bay of Bengal LME target a wide range of species, including sardine, anchovy, scad, shad, mackerel, snapper, emperor, grouper, pike-eel, tuna, shark, shrimp, bivalve and other shellfish.

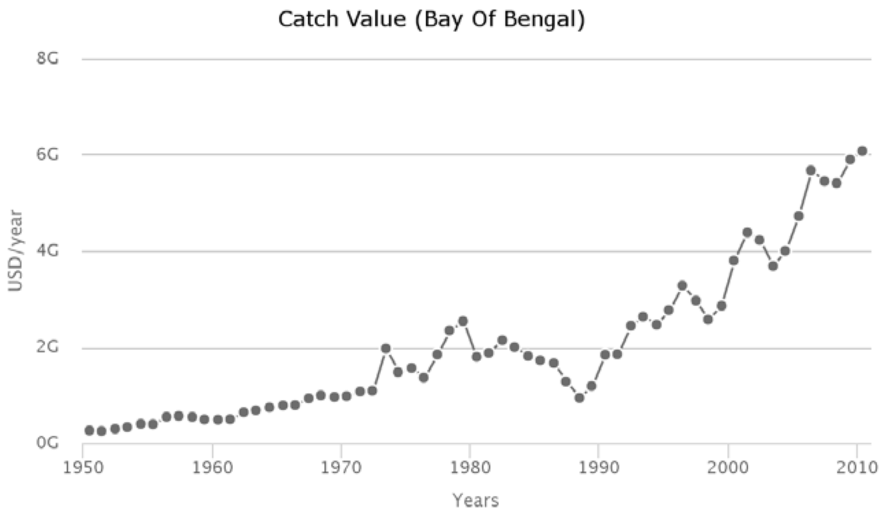
Annual Catch

Catches from commercial and subsistence fishing equal or exceed those from industrial fisheries. During the last decade, several countries have developed offshore fishing for tuna. There are strong indications that the continuous increase in the reported landings, particularly of unidentified fishes is a product of deficiencies in the underlying statistics, rather than improvements in the performance of the fisheries in the LME.



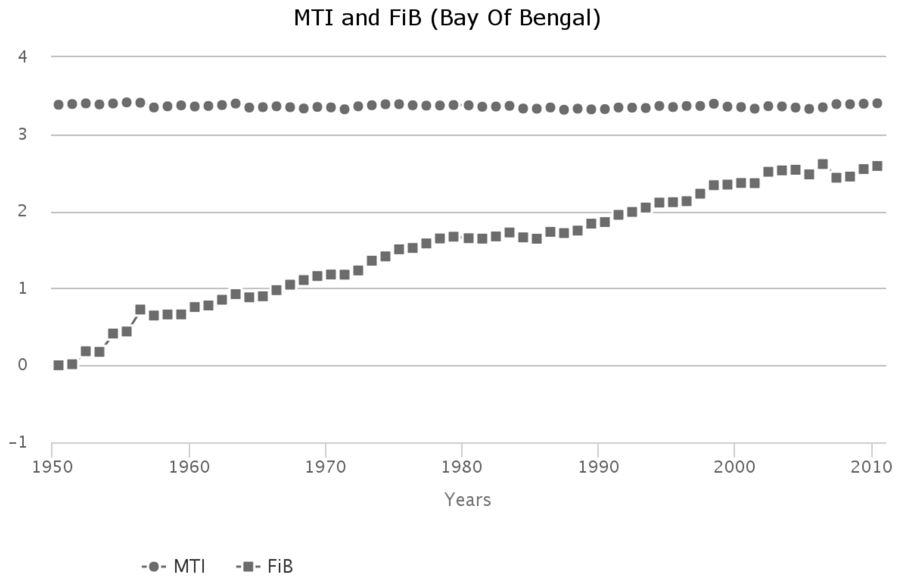
Catch value

Reported landing rose to about 1.2 million t in 2006 and the value of the reported landing reached a peak of about 5.7 billion US$ (in 2005 real US$) in the recent 5 years (2006 – 2010), but this figure is also questionable.



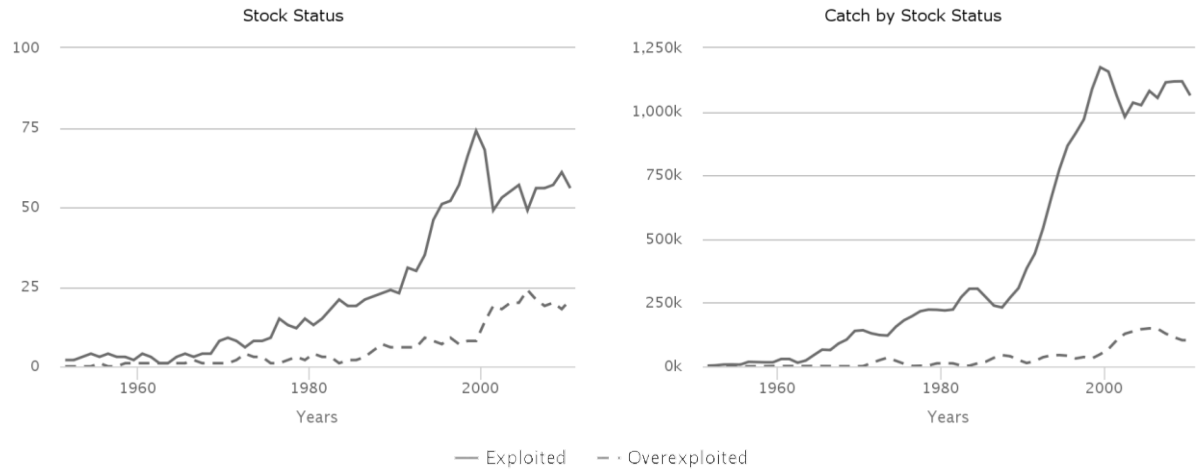
Marine Trophic Index and Fishing-in-Balance index

The MTI shows a steady decline over the past 60 years, while the FiB index increased over the same period. Due to the nature of the underlying landings statistics, it is not difficult to draw reliable conclusions from these indices; however, a detailed analysis of the MTI and FiB index of Western India, found that a 'fishing down' of the food webs indeed occurs in the region.



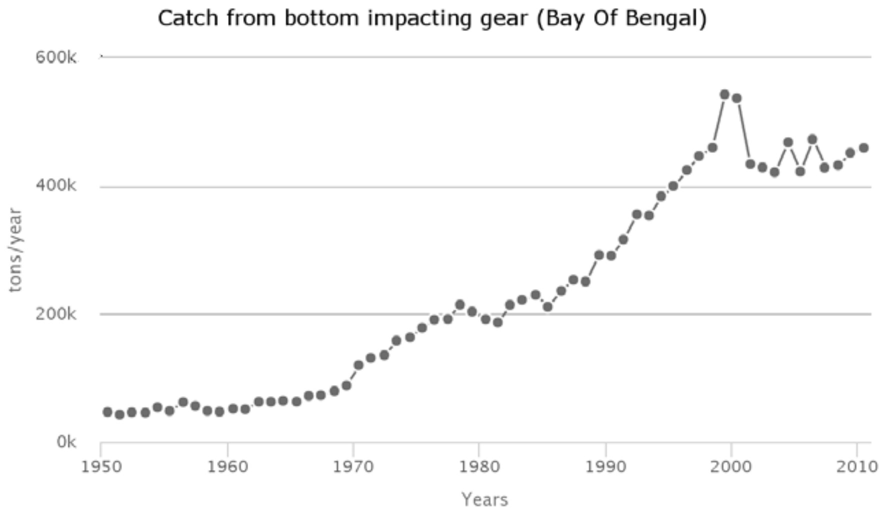
Stock status

The Stock-Catch Status Plots indicate that the number of collapsed and overexploited stocks in the LME is low but on the rise, with over 50% of the reported landings from fully exploited stocks. Again, the questionable quality of the underlying landings statistics must be noted.



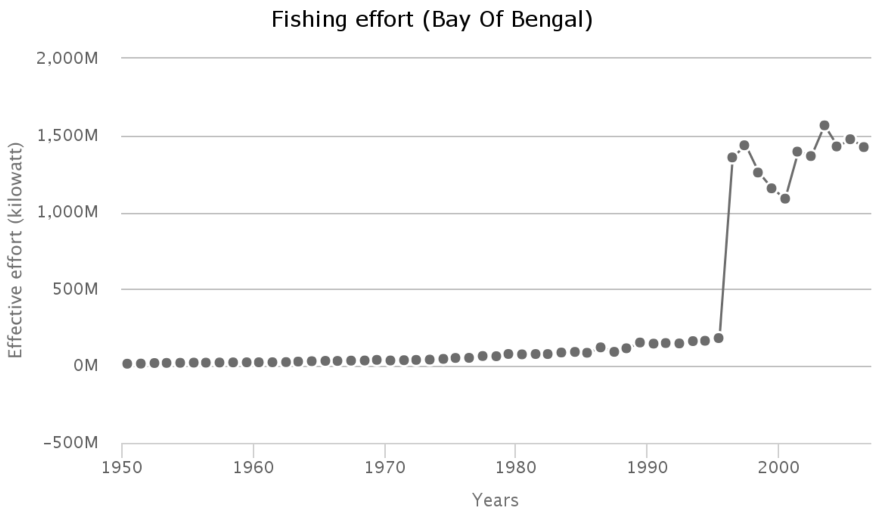
Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch decreased from 17% in 1950 to around 8% in the 1960s. Then, this percentage fluctuated between 10 and 18% in the following years.



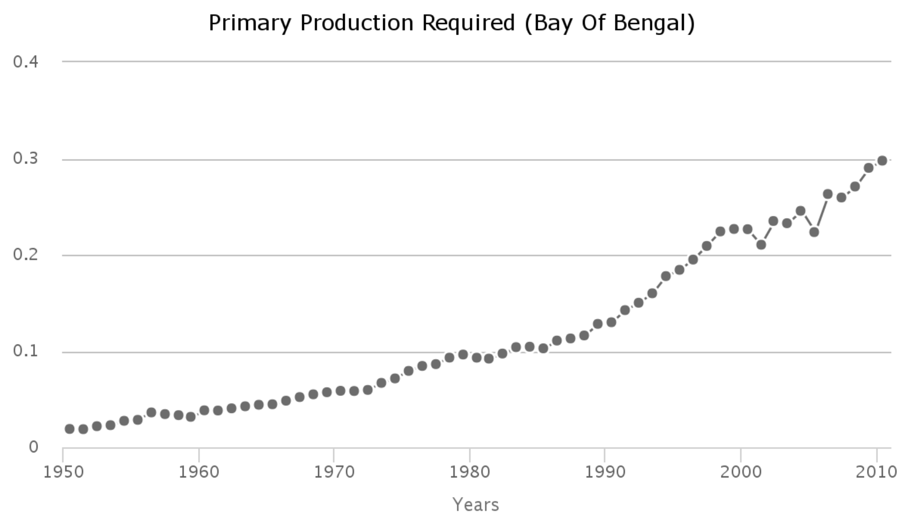
Fishing effort

The total effective effort was below 200 million kW from 1950 to the mid-1990s. Then, it increased sharply to 1,400 million kW in 1996 and it fluctuated around 1,400 million kW in the recent decade.



Primary Production Required

The primary production required (PPR) to sustain the reported landings in this LME has increased over the years, and reached 20% of the observed primary production in 1998, which may be another indication that the reported landings for this LME is overestimated.



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

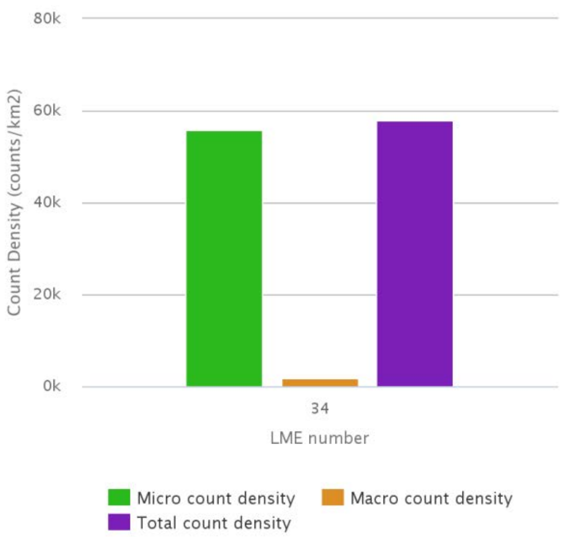
This LME covers the east coast of India, Sri Lanka and the west coast of Malaysia. Five samples at five locations are available. Average concentrations (ng.g^{-1} of pellets) were low: 36 (range 2-139 ng.g^{-1}) for PCBs, 17 (range 1-3 ng.g^{-1}) for DDTs, and 4.7 (range 3.2-6.2 ng.g^{-1}) for HCHs. All indicators correspond to risk category 2 of the five risk categories (1 = lowest risk; 5 = highest risk). Higher PCBs concentration at Chennai, India (139 ng.g^{-1}) may come from old electronic instruments, although the other location shows almost background level. Moderate concentrations of HCHs at a location in Port Dickson, Malaysia (6.2 ng.g^{-1} pellet) may suggest current usage of Lindane pesticide. Continuous monitoring and increase in spatial coverage is recommended.

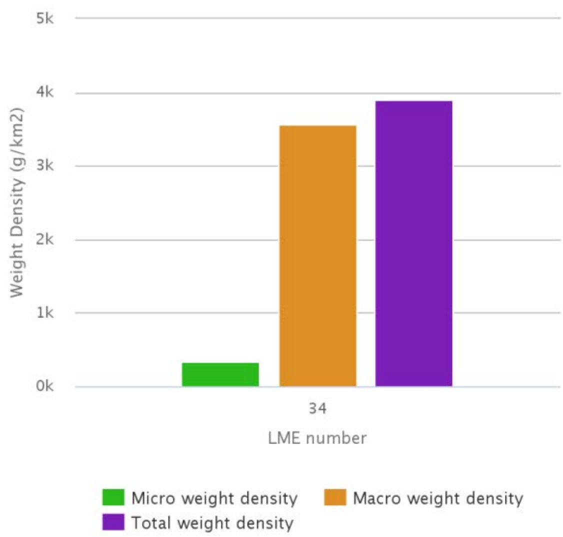
	PCBs		DDTs		HCHs	
Locations	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk
5	36	**2**	17	**2**	4.7	**2**

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 good evidence from sea-based direct observations and towed nets to support this conclusion.





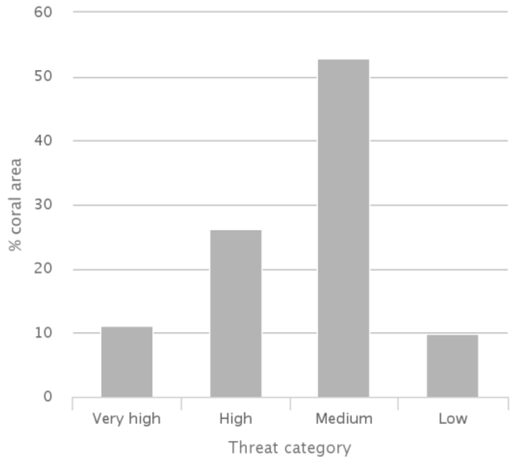
Ecosystem Health

Mangrove and coral cover

0.52% of this LME is covered by mangroves (0.52% of this LME is covered by mangroves (US Geological Survey, 2011) and 0.13% by coral reefs (Global Distribution of Coral Reefs, 2010).) and 0.13% 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 238. 11% of coral reefs cover is under very high threat, and 26% 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 21% and 27% for very high and high threat categories respectively. By year 2030, 23% 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 37% by 2050.

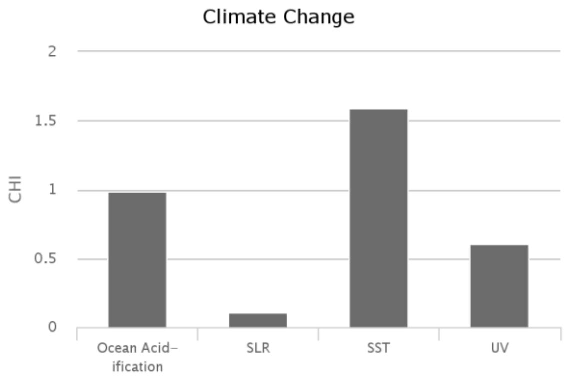


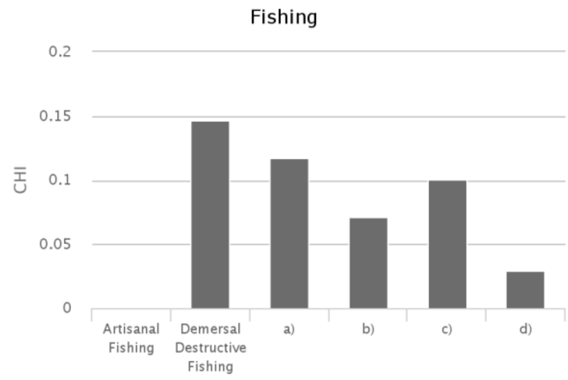
Marine Protected Area change

The Bay of Bengal LME experienced an increase in MPA coverage from 4,354 km2 prior to 1983 to 10,687 km2 by 2014. This represents an increase of 145%, within the low category of MPA change.

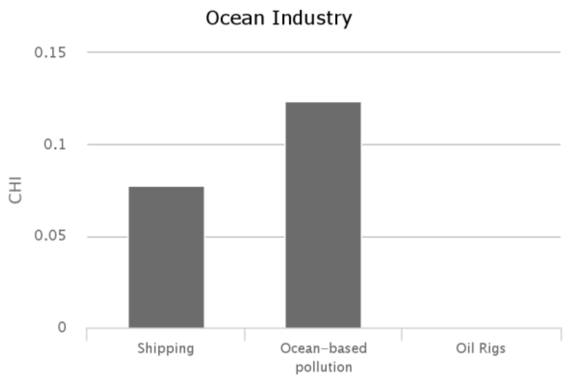
Cumulative Human Impact

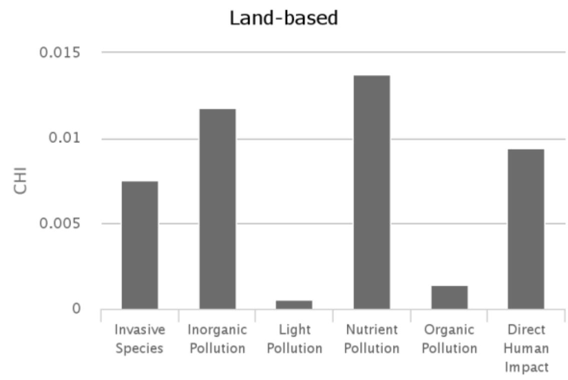
The Bay of Bengal LME experiences an above average overall cumulative human impact (score 4.00; maximum LME score 5.22). It falls in risk category 4 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (0.98; maximum in other LMEs was 1.20), UV radiation (0.61; maximum in other LMEs was 0.76), and sea surface temperature (1.59; maximum in other LMEs was 2.16). Other key stressors include commercial shipping, sea level rise, ocean based pollution, pelagic high-bycatch commercial fishing, and all three types of demersal commercial fishing (demersal destructive, non-destructive low-bycatch, and non-destructive high-bycatch).





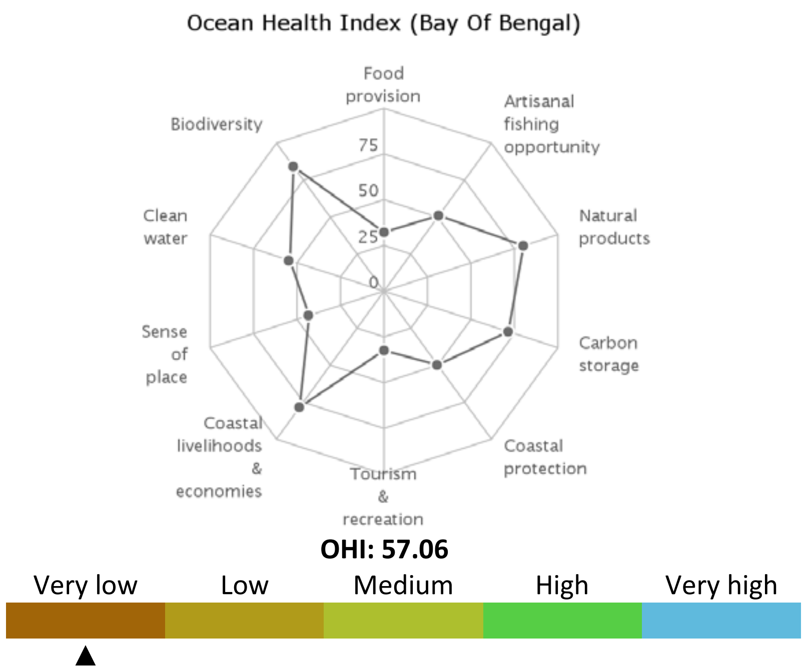
a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing





Ocean Health Index

The Bay of Bengal LME scores below average on the Ocean Health Index compared to other LMEs (score 62 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 increase 2 points 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, tourism & recreation, and sense of place goals and highest on artisanal fishing opportunities, coastal economies, and habitat biodiversity goals. 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 874 413 km^2. A current population of 323 389 thousand in 2010 is projected to increase to 501 774 thousand in 2100, with a density of 370 persons per km^2 in 2010 reaching 574 per km^2 by 2100. About 64% of coastal population lives in rural areas, and is projected to increase in share to 67% in 2100.

Total population		Rural population	
2010	2100	2010	2100
323,388,537	501,774,392	205,745,155	333,816,233

Legend: Very low | Low | Medium | High | Very high

Coastal poor

The indigent population makes up 25% of the LME's coastal dwellers. This LME places in the very high-risk category based on percentage and in the very high-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
81,353,809

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 $5 891 million for the period 2001-2010. Fish protein accounts for 32% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$57 951 million places it in the high-revenue category. On average, LME-based tourism income contributes 15% 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
5,891,137,757	32.4	57,222,138,090	14.6	0.8045

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 low HDI and very high-risk category. Based on an HDI of 0.604, this LME has an HDI Gap of 0.396, 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 increased population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.6037	0.8605	0.4429

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 risk under a fragmented world development pathway.

2010		2100	
Climate Threat	Contemporary Threat	SSP1	SSP3
1.0000	0.5923	0.4545	0.7210

Legend:

Very low | Low | Medium | High | Very high

Governance

Governance architecture

This LME is served by two Regional Seas Programme initiatives and several transboundary fisheries arrangements only one of which, the BOB IGO, is focussed on the LME. There does not appear to be any agency that is formally mandated to provide transboundary integration for the issues dealt with above. The BOBLME Project may be filling this role in an unofficial capacity. It also supports integration by facilitating and catalyzing cooperative activities and capacity development.
The overall scores for ranking of risk were:

Engagement	Completeness	Integration
87	**50**	**0.1**

Legend:

Very low | Low | Medium | High | Very high

LME 35 – Gulf of Thailand

Bordering countries: Cambodia, Malaysia, Thailand, Viet Nam
LME Total area: 391,665 km^2

List of indicators

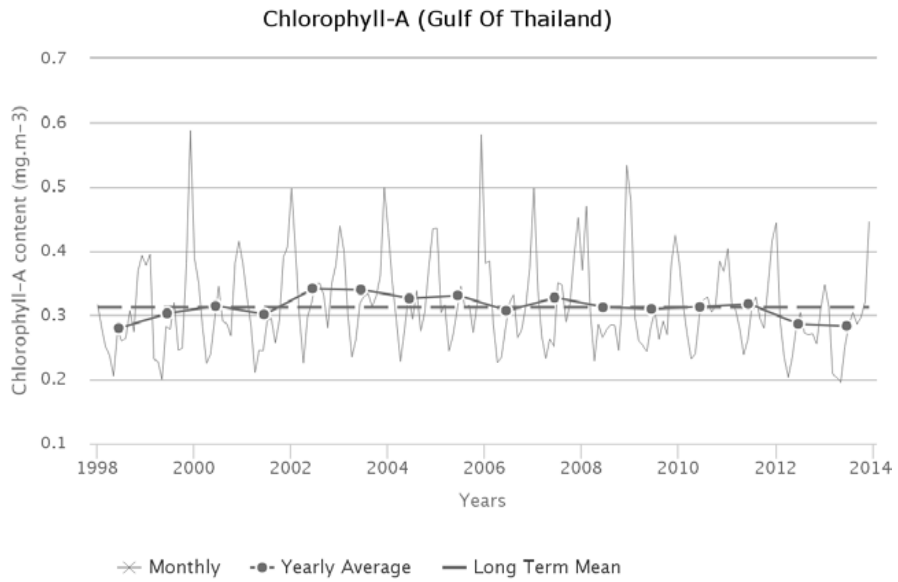
LME overall risk

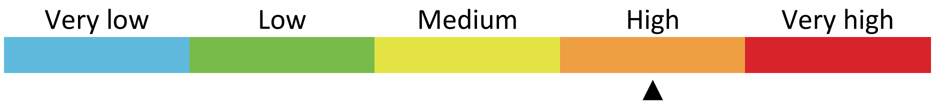
This LME falls in the cluster of LMEs that exhibit low to levels of economic development (based on the night light development index) and high pollution from plastic debris.
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very high.

Productivity

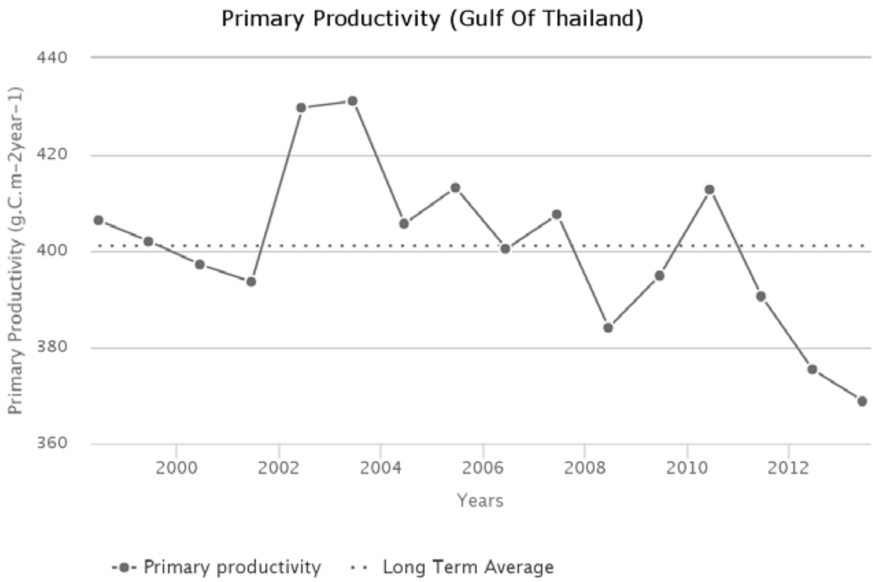
Chlorophyll-A

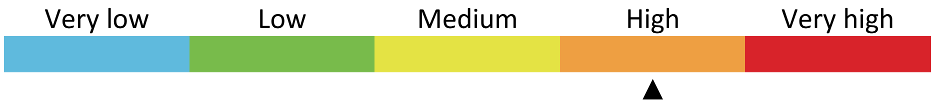
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.437 $mg.m^{-3}$) in December and a minimum (0.236 $mg.m^{-3}$) during April. The average CHL is 0.312 $mg.m^{-3}$. Maximum primary productivity (431 $g.C.m^{-2}.y^{-1}$) occurred during 2003 and minimum primary productivity (369 $g.C.m^{-2}.y^{-1}$) during 2013. There is a statistically insignificant decreasing trend in Chlorophyll of -1.84 % from 2003 through 2013. The average primary productivity is 401 $g.C.m^{-2}.y^{-1}$, which places this LME in Group 4 of 5 categories (with 1 = lowest and 5= highest).





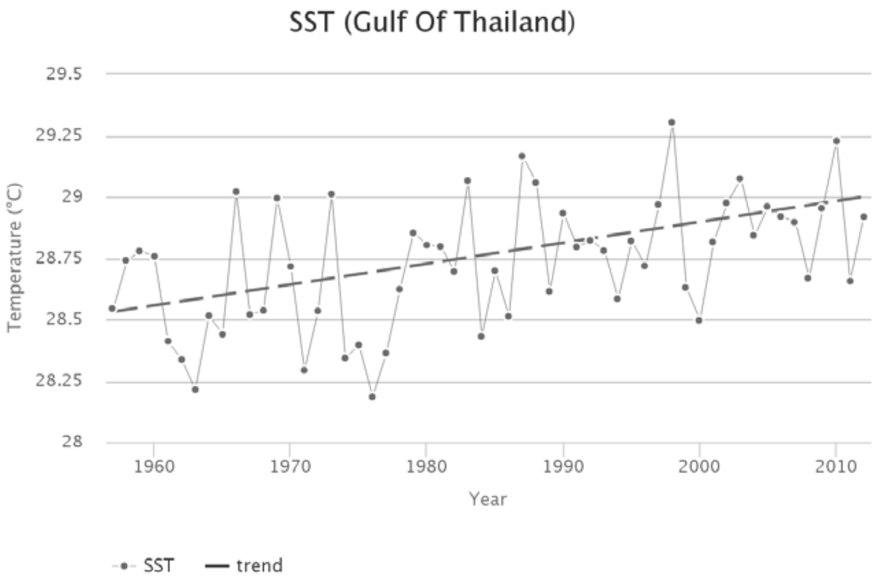
Primary productivity





Sea Surface Temperature

From 1957 to 2012, the Gulf of Thailand LME #35 has warmed by 0.42°C, thus belonging to Category 3 (moderate warming LME). The Gulf of Thailand LME is wide open to the South China Sea LME #36, so their thermal regimes are linked. The relative magnitude of corresponding peaks and troughs is however different between these LMEs. The Gulf of Thailand's steady warming was modulated by relatively strong interannual variability with year-to-year variations exceeding 0.5°C. The SST peak of 1998 stands out. This event was likely related to the El Niño 1997-98. Other pronounced events are: (1) near-all-time minimum of 1963, simultaneous with a SST minimum in the South China Sea LME #36; (2) absolute minimum of 1976, which corresponds to a minimum in the South China Sea.

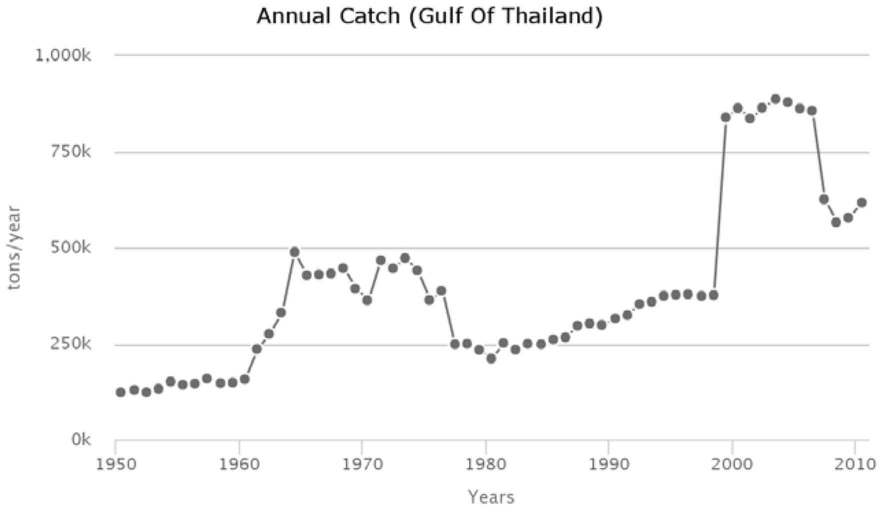


Fish and Fisheries

The catch composition of the Gulf of Thailand LME is a tropical multi-species mix and includes food fish, trash fish, squid and cuttlefish, shrimp, shellfish and crab. Until the early 1960s, the fisheries were dominated by small pelagics (mainly Indian mackerels, *Rastrelliger spp.* and anchovies, *Stolephorus spp.*), caught by artisanal fishers for local markets. In the 1960s, the introduction of trawl gear led to the development of demersal trawl fisheries targeting various demersal fishes, shrimps and squid.

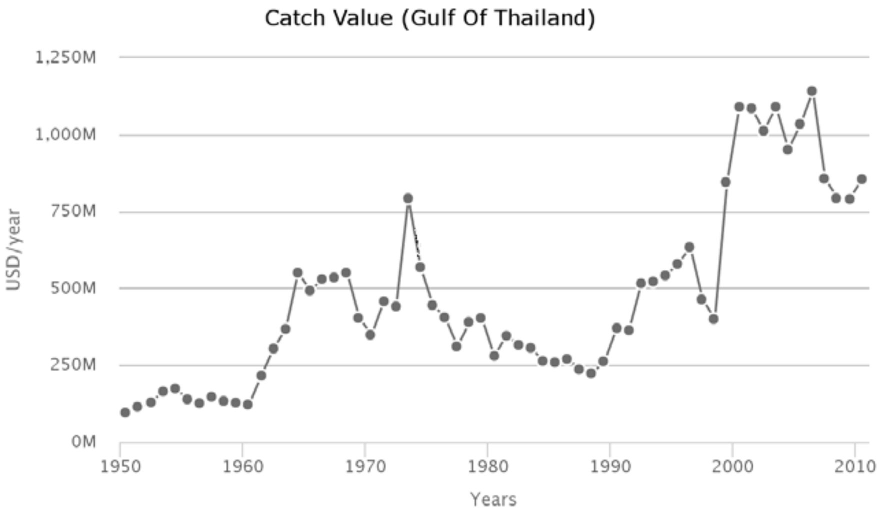
Annual Catch

Total reported landings rose to over a million t in 1969, but this is probably due to misreporting of fish caught outside the Gulf. After 1969, the landings declined to less than 500,000 t by the late 1970s, but gradually returning to just under 900,000 t by 2003. Again, a large fraction of the increased landings in recent years was probably caught outside of the LME, notably tuna. Note the high level of 'mixed group' in the reported landings.



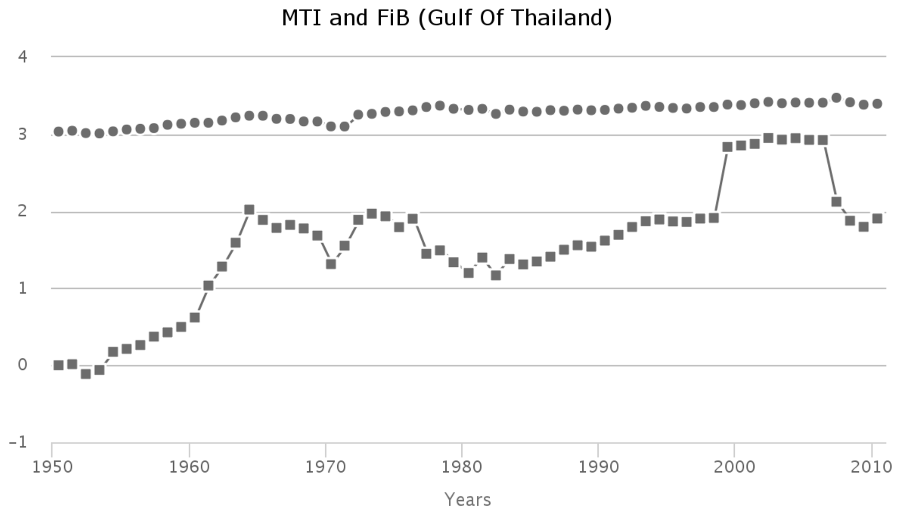
Catch value

The value of the reported landings peaked at about 1.1 billion US$ (in 2005 real US$) in 2006.



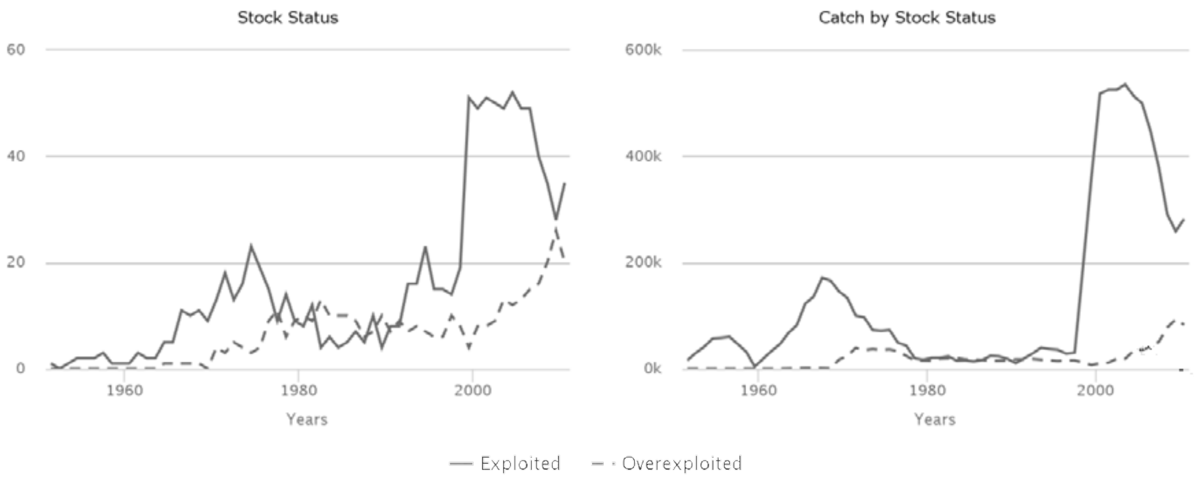
Marine Trophic Index and Fishing-in-Balance index

The trends in the MTI and the FiB are indicative of growing fisheries in the LME. However, due to the poor taxonomic details in the underlying landings statistics it is highly likely that such diagnosis is incorrect.



Stock status

The Stock-Catch Status Plots indicate that almost 30% of the stocks in the LME are either collapsed or overexploited, and that they contribute less than 15% of the catch. Again, the high degree of taxonomic aggregation in the underlying statistics must be noted in regards to problems in the interpretation of these plots.

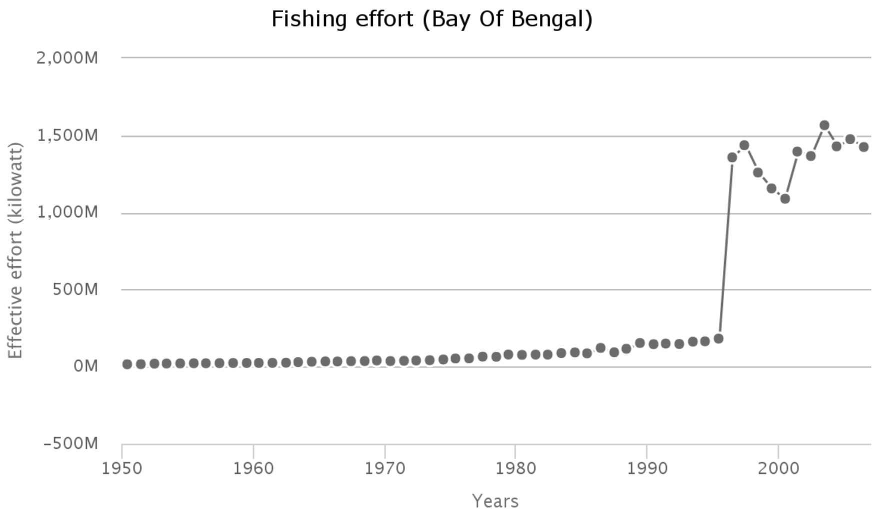


Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch increased from 14% in the 1950s to its first peak at around 29% in 1972. Then, this percentage kept decreasing and fluctuated around 25% in recent decade.

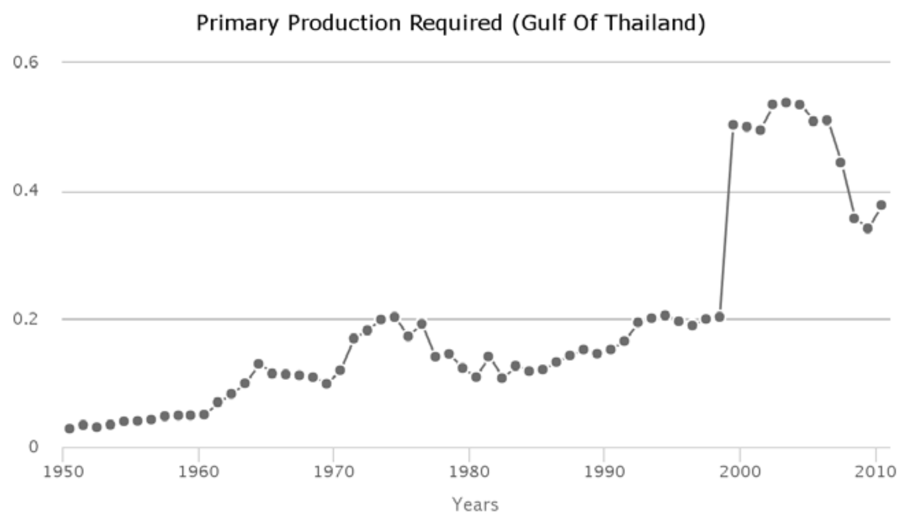
Fishing effort

The total effective effort continuously increased from around 10 million kW in the 1950s to its peak around 200 million kW in 1999.



Primary Production Required

The primary production required (PPR) to sustain the reported landings in this LME peaked in the early 1970s at 30% of the observed primary production, and following a period of low PPR, has again reached this level 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 low (level 2 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this remained low in 2030 and increased to moderate by 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was very low (1). According to the Global Orchestration scenario, this increased to low in 2030 and increased further to moderate in 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was low (2). According to the Global Orchestration scenario, this remained the same in 2030 and increased to moderate in 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
2	1	2	2	2	2	3	3	3

Legend:

Very low   Low   Medium   High   Very high

POPs

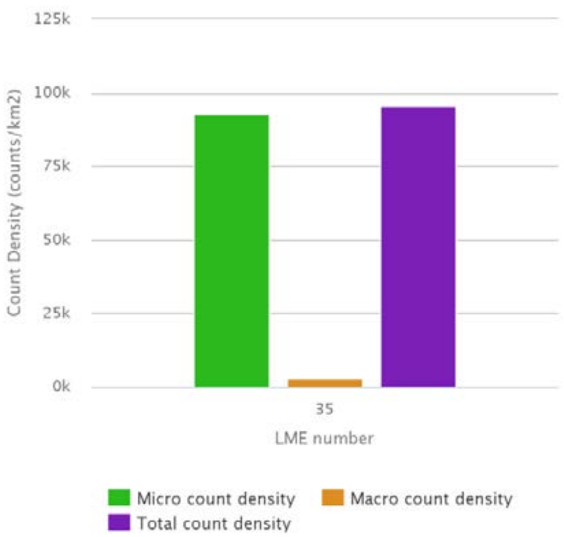
Data are available only for one sample at one location in Thailand. This location shows minimal concentration (ng.g^{-1} of pellets) of 5 ng.g^{-1} for PCBs and 0.2 ng.g^{-1} for HCHs, while moderate concentration of 26 ng.g^{-1} for DDTs. These correspond to risk categories 1 for PCBs and HCHs, and 3 for DDTs, of the five risk categories (1 = lowest risk; 5 = highest risk). Recent application of DDT pesticide for Malaria control might have occurred. Extensive monitoring is necessary in this LME.

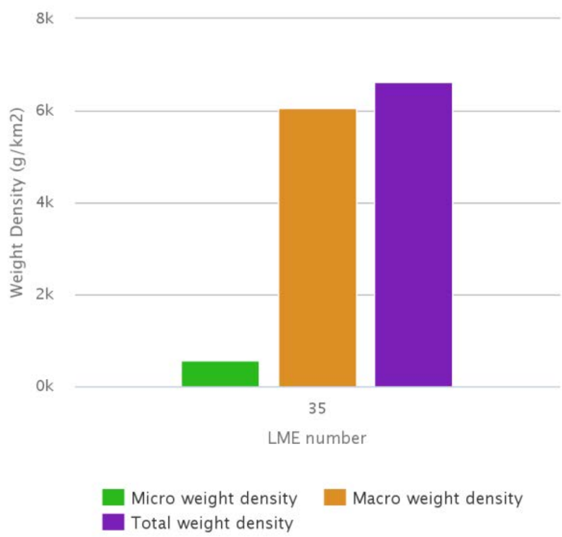
	PCBs		DDTs		HCHs	
Locations	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk
1	5	1	26	3	0.2	1

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.





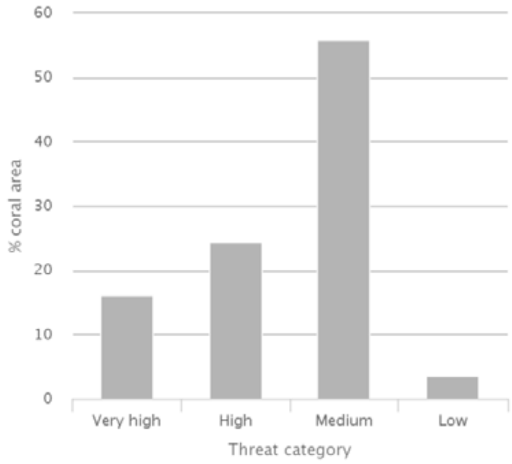
Ecosystem Health

Mangrove and coral cover

0.46% of this LME is covered by mangroves (US Geological Survey, 2011) and 0.17% 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 253. 16% of coral reefs cover is under very high threat, and 24% 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 24% and 47% for very high and high threat categories respectively. By year 2030, 27% 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 41% by 2050.

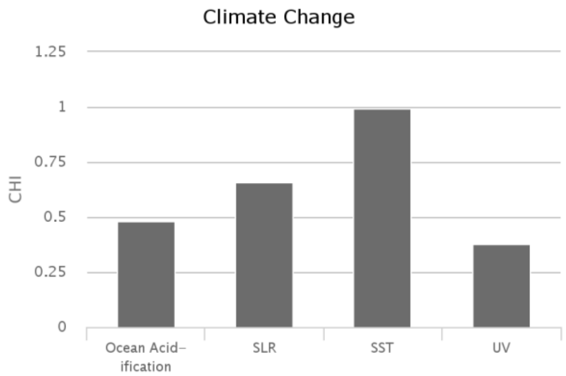


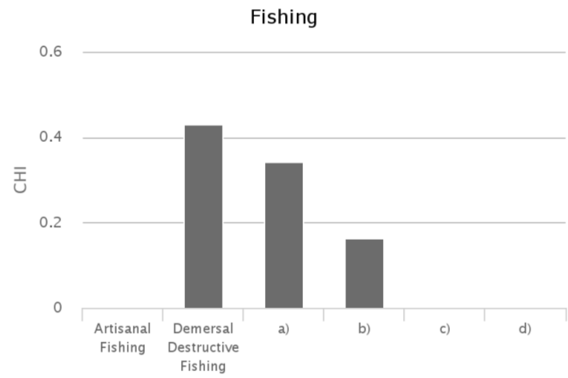
Marine Protected Area change

The Gulf of Thailand LME experienced an increase in MPA coverage from 721 km^2 prior to 1983 to 1,927 km^2 by 2014. This represents an increase of 167%, within the low category of MPA change.

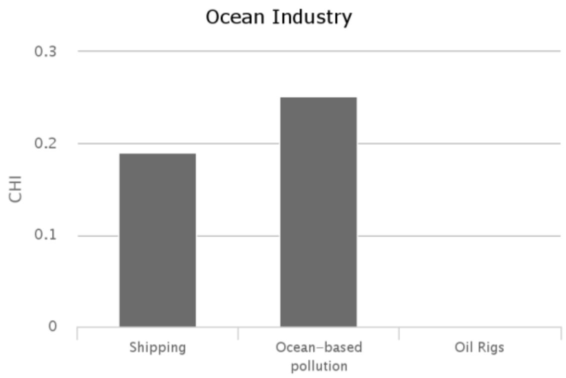
Cumulative Human Impact

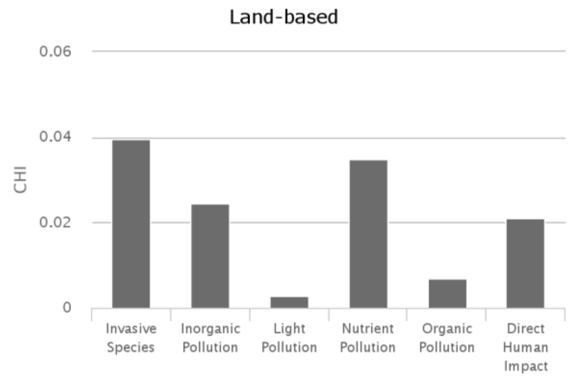
The Gulf of Thailand LME experiences an above average overall cumulative human impact (score 4.03; maximum LME score 5.22), which is also well above the LME with the least cumulative impact. It falls in risk category 4 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, all four connected to climate change have the highest average impact on the LME: ocean acidification (0.48; maximum in other LMEs was 1.20), UV radiation (0.38; maximum in other LMEs was 0.76), sea level rise (0.66; maximum in other LMEs was 0.71), and sea surface temperature (0.99; maximum in other LMEs was 2.16). Other key stressors include commercial shipping, nutrient runoff from land, ocean based pollution, invasive species, and all three types of demersal commercial fishing (demersal destructive, non-destructive low-bycatch, and non-destructive high-bycatch).

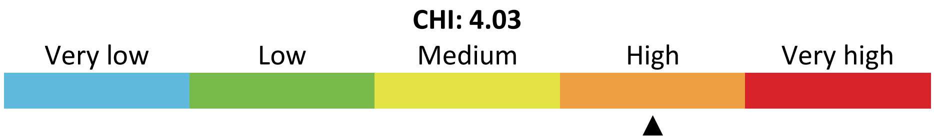




a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing

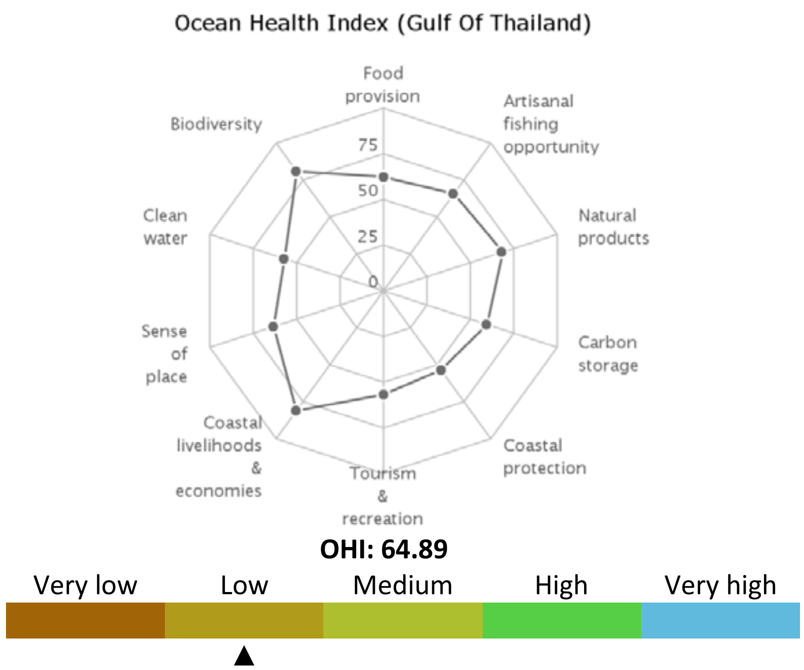






Ocean Health Index

The Gulf of Thailand 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 increased 1 point compared to the previous year, due in large part to changes in the scores for natural products and coastal livelihoods. This LME scores lowest on fisheries, coastal protection, carbon storage and iconic species goals and highest on artisanal fishing opportunities and coastal economies 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 230 482 km^2. A current population of 38 106 thousand in 2010 is projected to increase to 62 702 thousand in 2100, with a density of 165 persons per km^2 in 2010 reaching 272 per km^2 by 2100. About 54% 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
38,106,496	62,702,332	20,578,044	36,643,171

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 high-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
5,806,063

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 $1 143 million for the period 2001-2010. Fish protein accounts for 38% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$33 128 million places it in the high-revenue category. On average, LME-based tourism income contributes 17% 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
1,143,028,121	38.0	33,127,745,647	17.0	0.8004

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 0.717, this LME has an HDI Gap of 0.283, 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 increased population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.7168	0.8998	0.5243

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**
0.7827	0.5273	0.3894	0.6499

Legend:

Very low | Low | Medium | High | Very high

Governance

Governance architecture

The two transboundary arrangements for fisheries (APFIC and WCPFC) in the area each 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. However, the arrangement for the Regional Seas Programme cover both for pollution and biodiversity, falling under the Coordinating Body of the Seas of South east Asia (COBSEA), with linkages to the Partnership in Environmental Management for the Seas of East Asia (PEMSEA). Also, the “within national jurisdiction” arrangements for fisheries, pollution and biodiversity do not appear to be integrated with each 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
75	50	0.1

Legend:

Very low | Low | Medium | High | Very high

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.

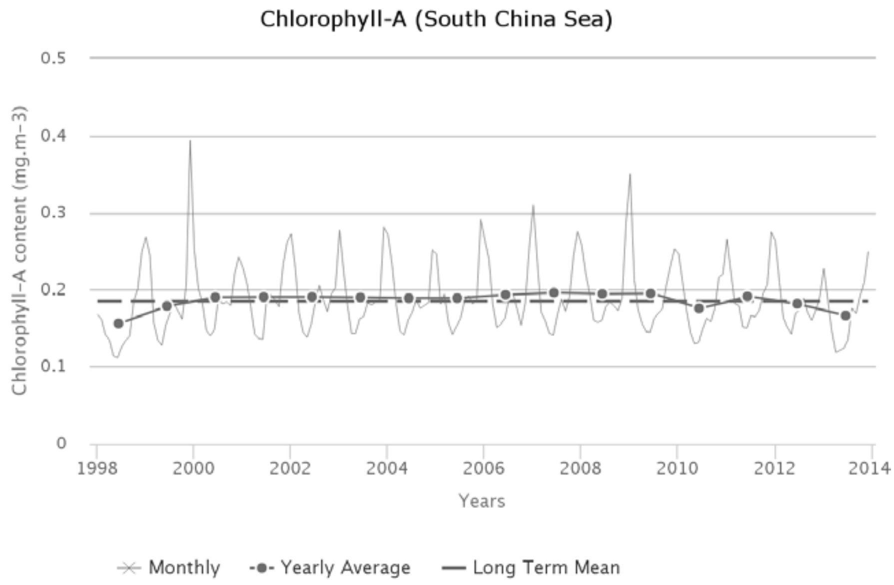
Very low | Low | Medium | High | Very high

▲ (Very high)

Productivity

Chlorophyll-A

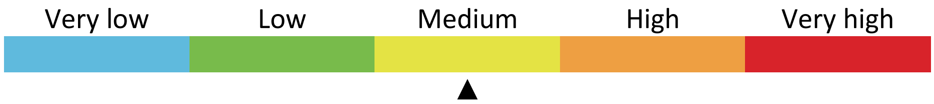
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.270 mg.m^{-3}) in January and a minimum (0.139 mg.m^{-3}) during May. The average CHL is 0.185 mg.m^{-3}. Maximum primary productivity (295 g.C.m^{-2}.y^{-1}) occurred during 2007 and minimum primary productivity (263 g.C.m^{-2}.y^{-1}) 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

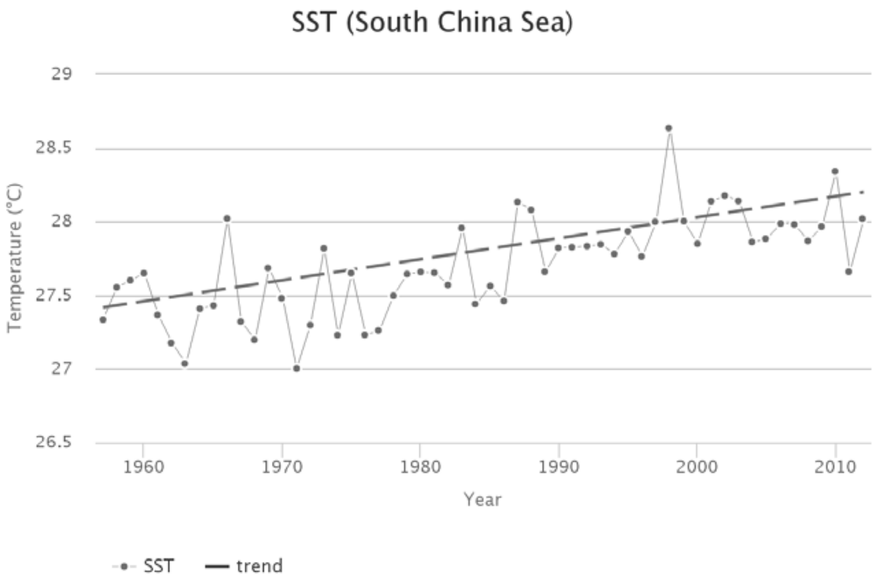
▲ (Medium)

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.

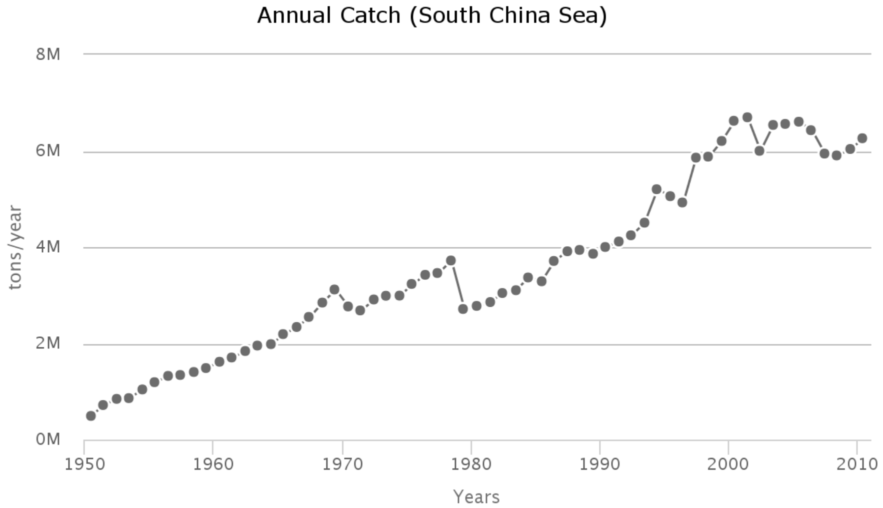


Fish and Fisheries

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.

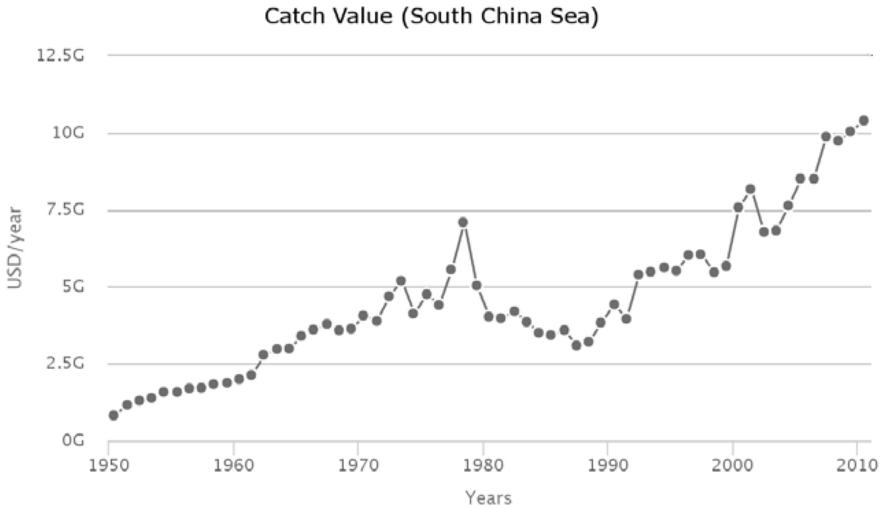
Annual Catch

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.



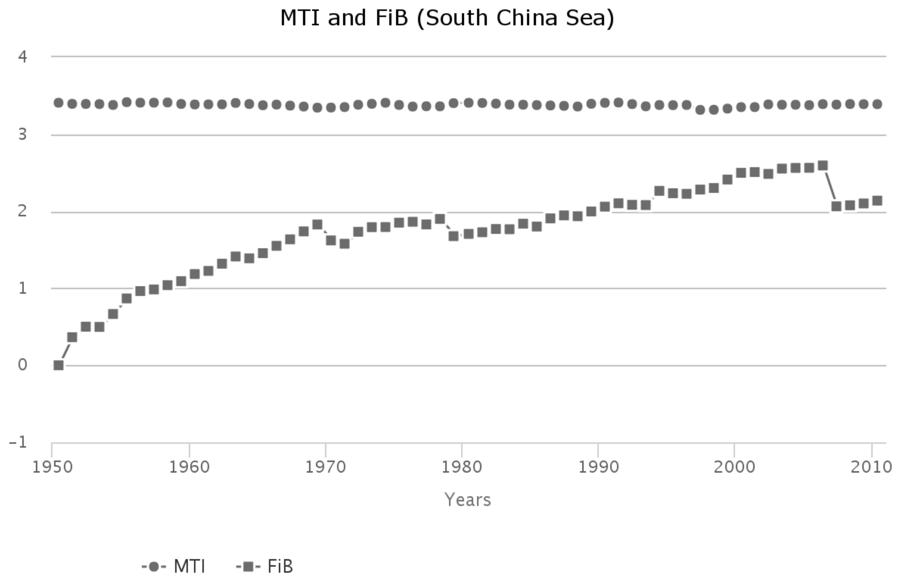
Catch value

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).



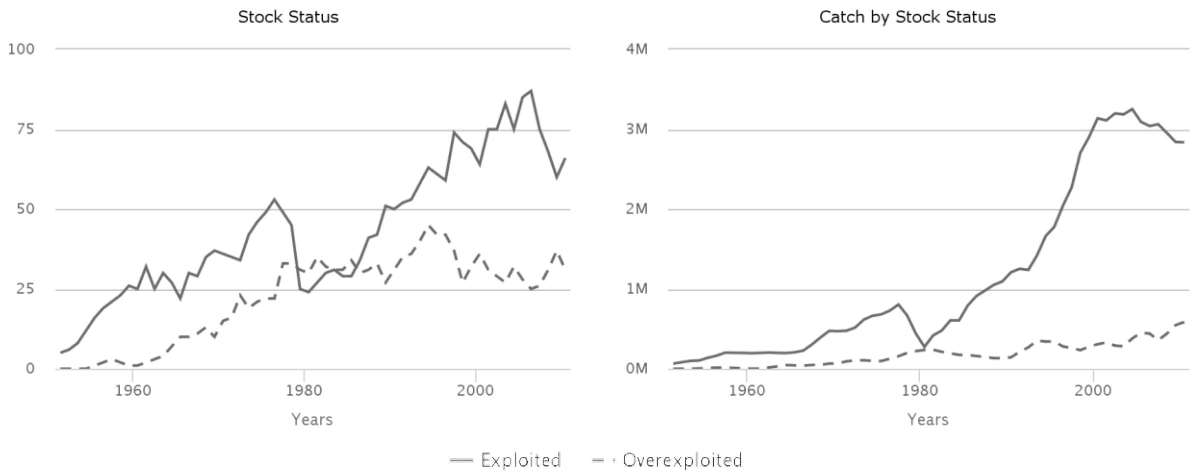
Marine Trophic Index and Fishing-in-Balance index

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.



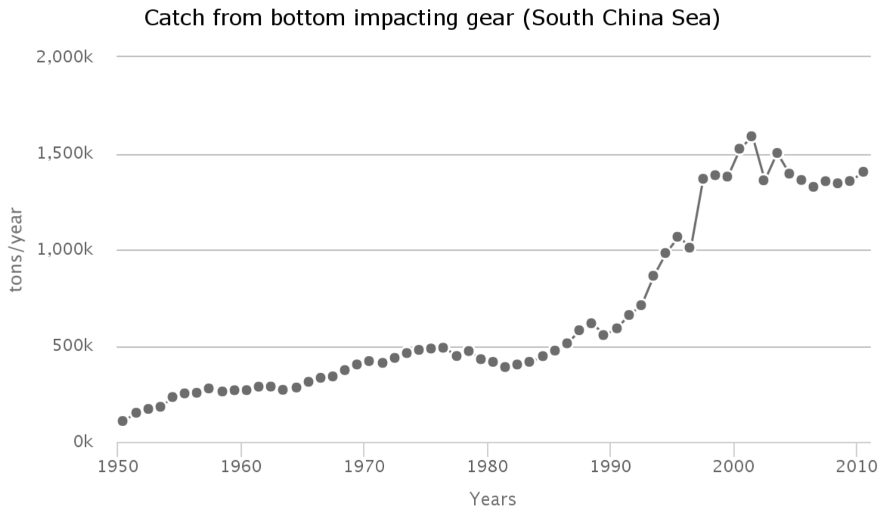
Stock status

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.



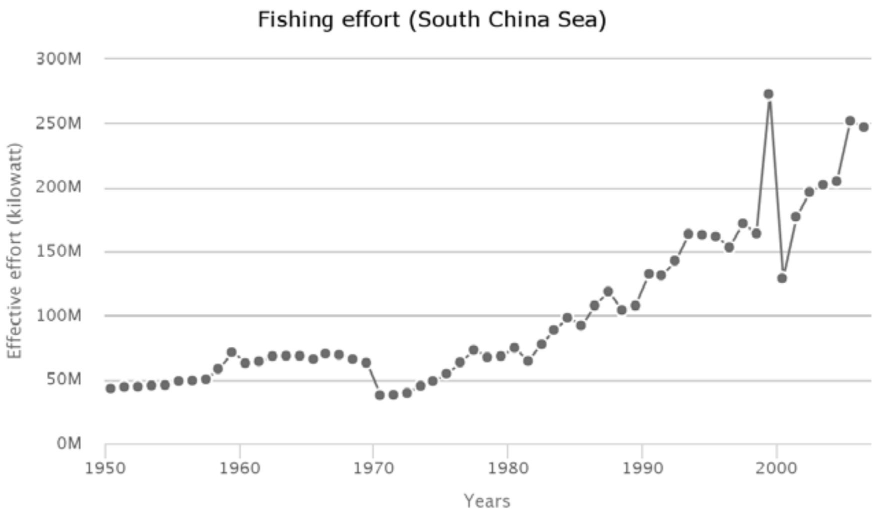
Catch from bottom impacting gear

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.



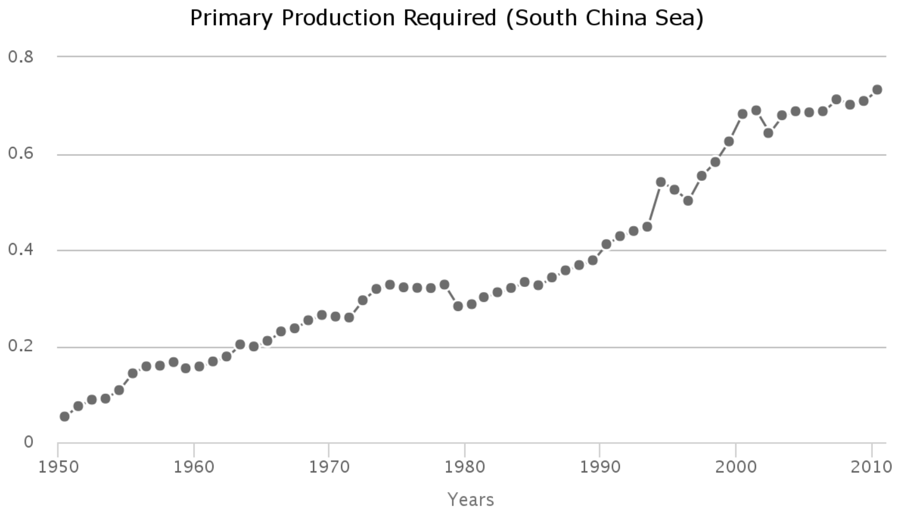
Fishing effort

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

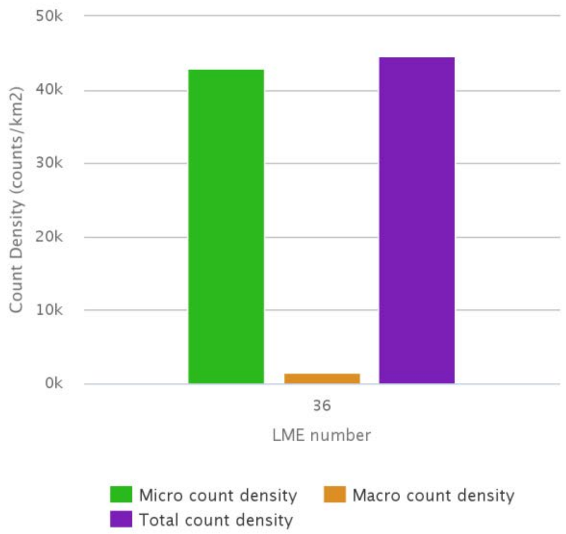
This LME includes Vietnam and Southern China. Twelve samples at 11 locations are available. Average concentrations (ng.g^{-1} of pellets) were high for DDT (176, range 1-558 ng.g^{-1}), moderate for PCBs (97, range 8-757 ng.g^{-1}), and minimal for HCHs (1.2, range 0.2-208 ng.g^{-1}). These averages 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.

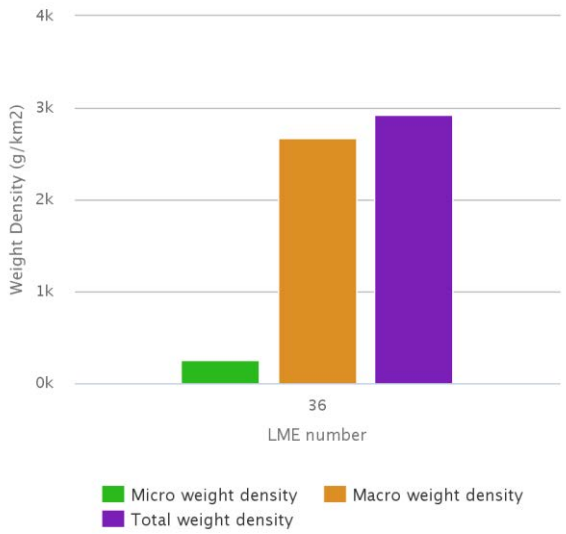
	PCBs		DDTs		HCHs	
Locations	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk
12	97	3	176	4	1.2	1

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.





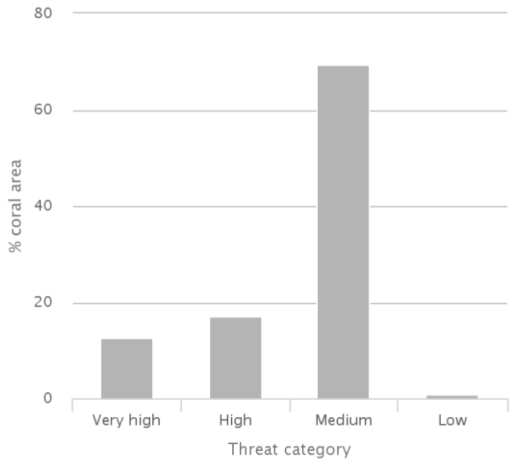
Ecosystem Health

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.

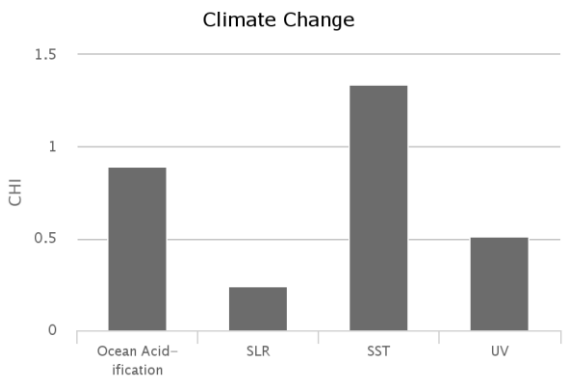


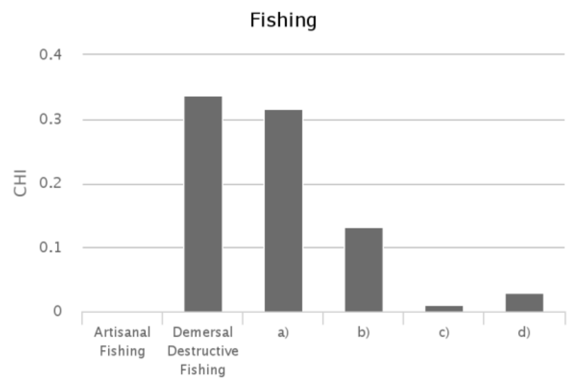
Marine Protected Area change

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.

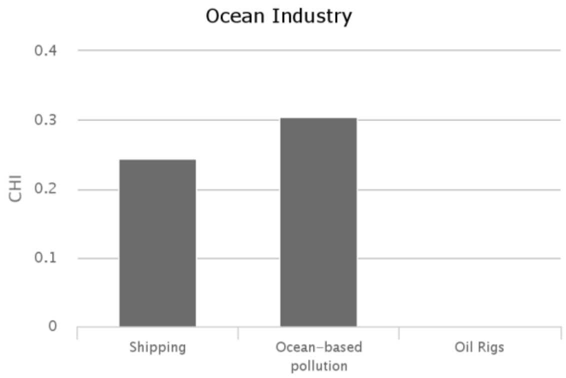
Cumulative Human Impact

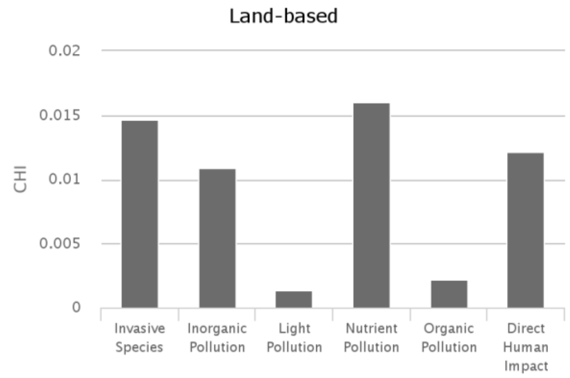
The South China Sea LME experiences well above average overall cumulative human impact (score 4.42; maximum LME score 5.22). It falls in risk category 5 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, all 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.

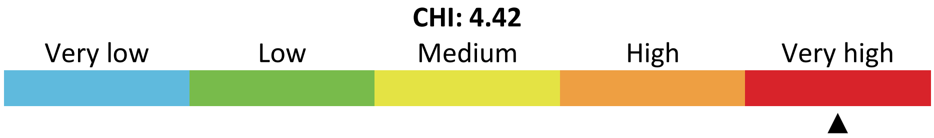




a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing

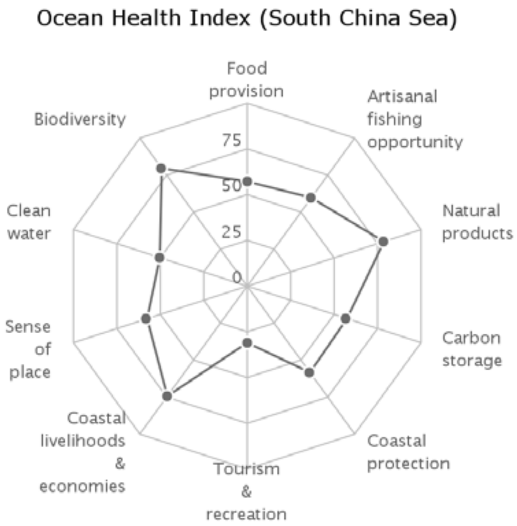






Ocean Health Index

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).



OHI: 60.4

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 37 – Sulu Celebes Sea

Bordering countries: Indonesia, Malaysia.
LME Total area: 1,015,737 km^2

List of indicators

LME overall risk

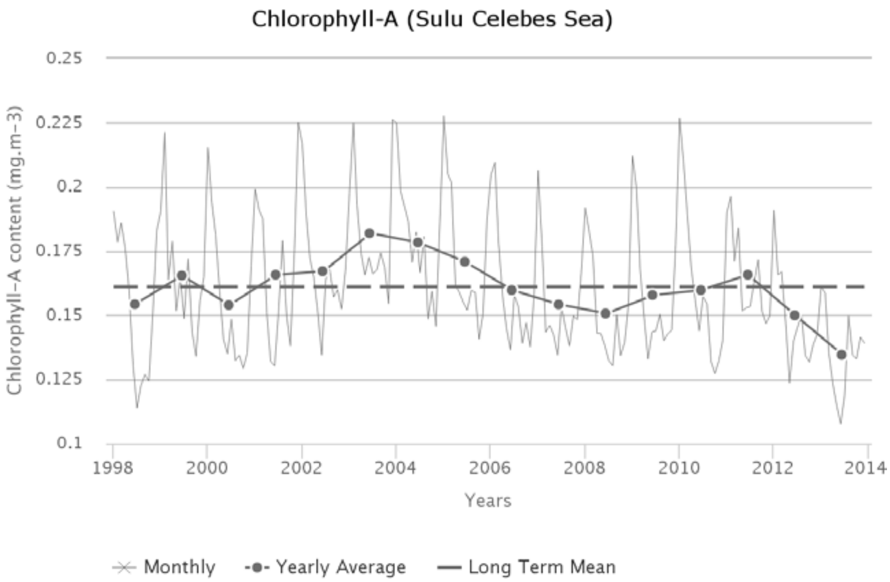
This LME falls in the cluster of LMEs that exhibit low to levels of economic development (based on the night light development index) and high pollution from plastic debris.

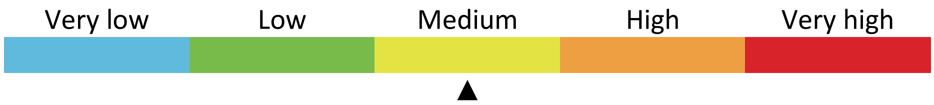
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very high.

Productivity

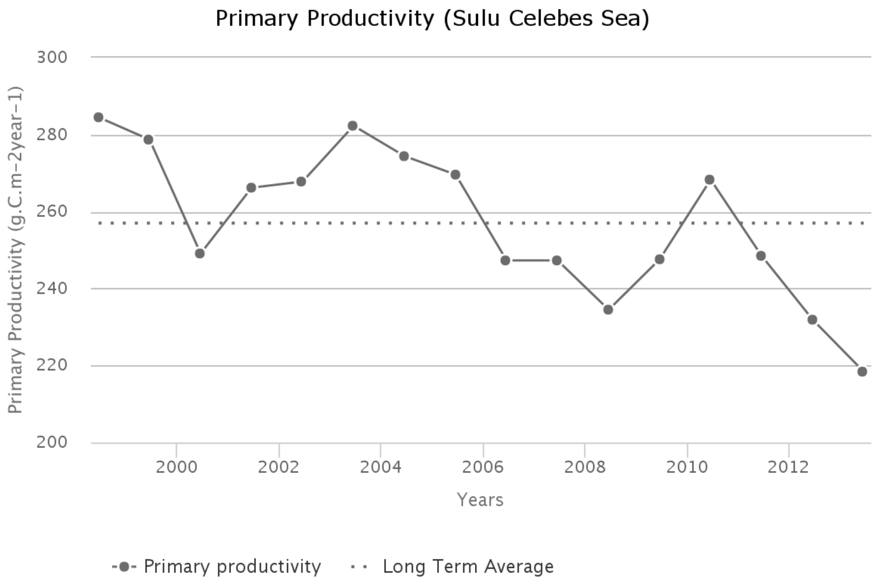
Chlorophyll-A

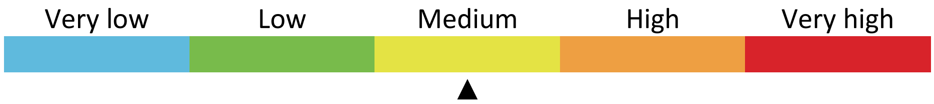
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.204 mg.m^{-3}) in January and a minimum (0.144 mg.m^{-3}) during June. The average CHL is 0.161 mg.m^{-3}. Maximum primary productivity (284 g.C.m^{-2}.y^{-1}) occurred during 1998 and minimum primary productivity (218 g.C.m^{-2}.y^{-1}) during 2013. There is a statistically insignificant decreasing trend in Chlorophyll of -19.5 % from 2003 through 2013. The average primary productivity is 257 g.C.m^{-2}.y^{-1}, which places this LME in Group 3 of 5 categories (with 1 = lowest and 5= highest).





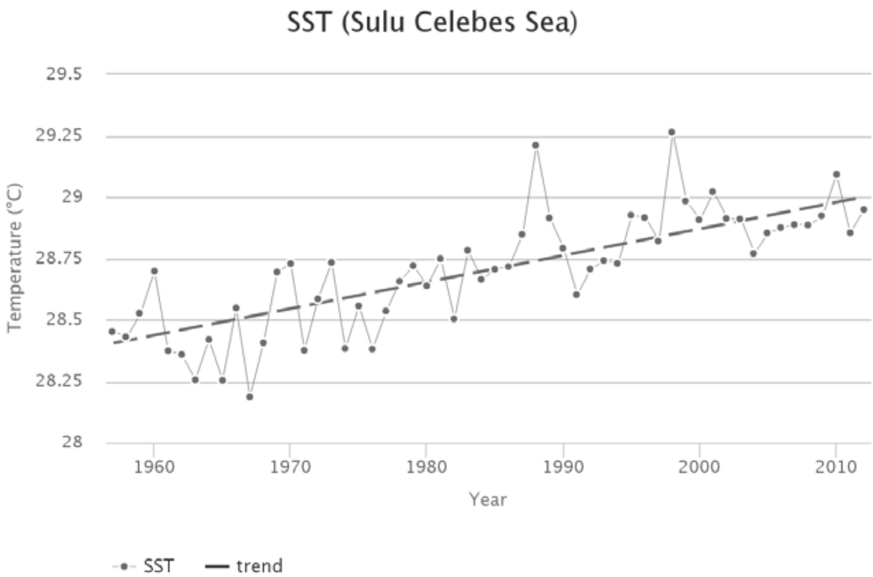
Primary productivity





Sea Surface Temperature

From 1957 to 2012, the Sulu-Celebes Sea LME #37 has warmed by 0.64°C, thus belonging to Category 3 (moderate warming LME). The steady warming of the Sulu-Celebes Sea was accentuated by two warm events, in 1988 and 1998, the latter being of the global scale (El Niño 1997-98). The warm event of 1988 occurred simultaneously in the Indonesian Sea LME #38, North Australian Shelf LME #39, West-Central Australian Shelf LME #44, and Northwest Australian Shelf LME #45; and only one year prior to the warm event of 1989 in the Southeast Australian Shelf LME #42. Apparently, the warm event of 1988 was caused by large-scale forcing. The all-time minimum of 1967 occurred simultaneously in the Indonesian Sea LME #38 and one year prior to the all-time minimum of 1968 in the West-Central Australian Shelf LME #44. The strong correlation between the Sulu-Celebes Sea's thermal history and those of adjacent seas could be explained by oceanic circulation, particularly, the Indonesian Throughflow that flows through these LMEs.

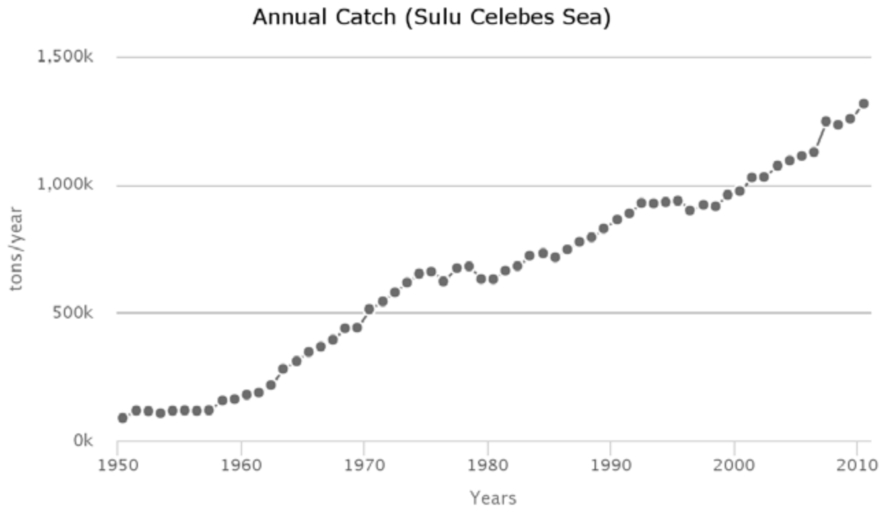


Fish and Fisheries

The fisheries of the Sulu-Celebes Sea LME are multi-gear and multi-species. Reef fisheries provide essential sustenance to artisanal fishers and their families throughout the region while high value fish products are exported to expanding international, national as well as local markets.

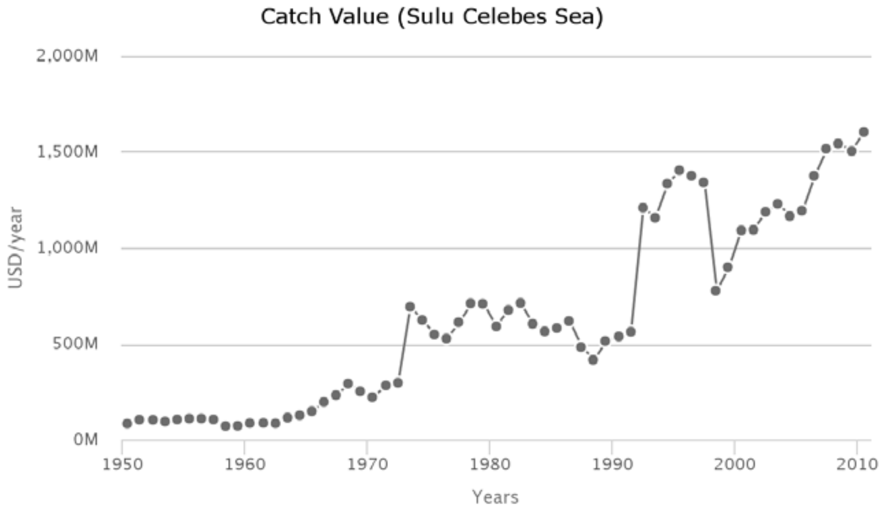
Annual Catch

Total reported landings in the LME have increased steadily, recording an average of one million t in the recent decade (2001 – 2010), although there is a significant proportion of the landings being reported simply as unidentified fishes in the available statistics.



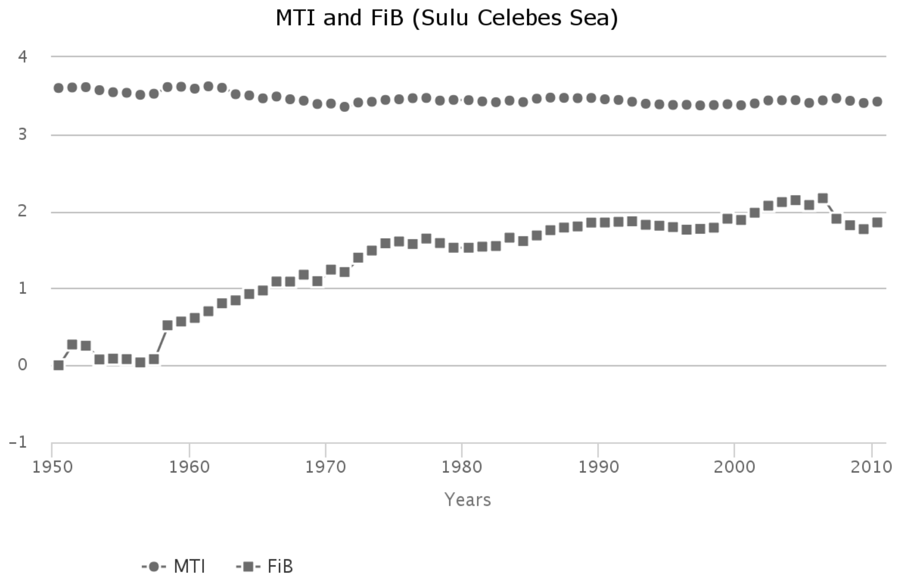
Catch value

The value of the reported landings has also increased, exceeding 1.5 billion US$ (in 2005 real US$) in recent years.



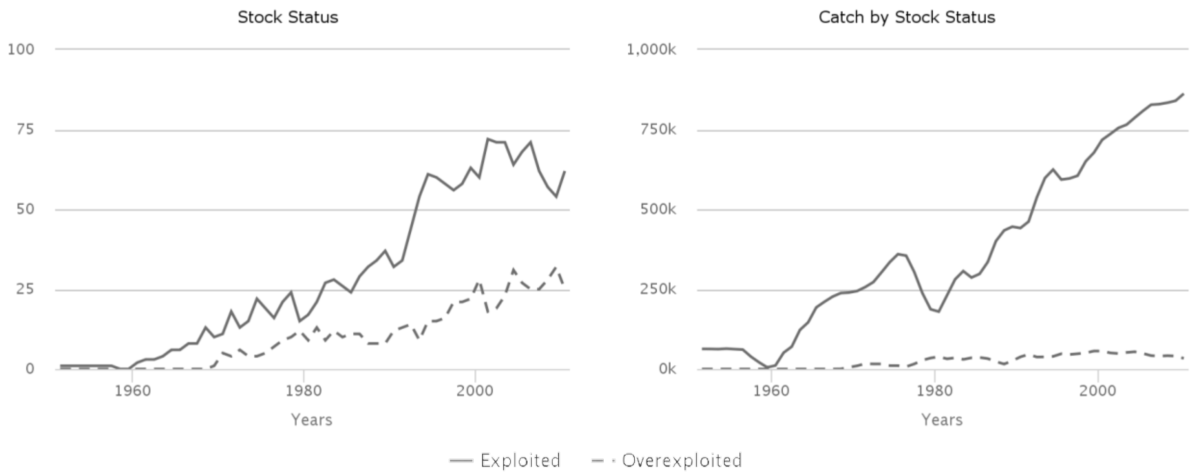
Marine Trophic Index and Fishing-in-Balance index

The trends in MTI and FiB are not conclusive, likely because of the poor quality of the underlying landings statistics. However, a decline in the MTI can be seen from 1950 to 1974, a period in which the proportion of unidentified fish in the landings statistics was relatively small, an indication that a 'fishing down' of the food web is occurring in the LME, only to be drowned out by the high level of taxonomically over-aggregated catches in recent years.



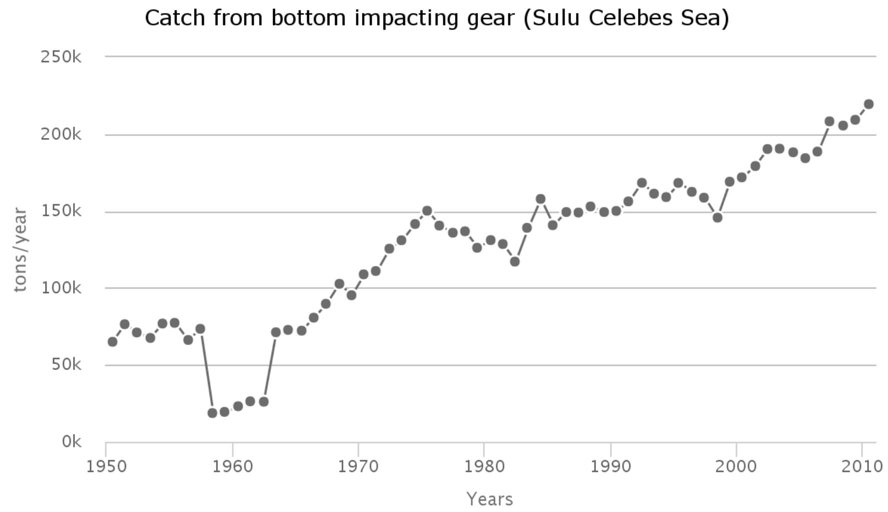
Stock status

The Stock-Catch Status Plots indicate that about 27% of the stocks in the LME have collapsed or are currently overexploited, and that the reported landings are largely supplied by fully exploited stocks (almost 70%). This diagnosis, however, is probably a result of the high degree of taxonomical aggregation in the underlying statistics.



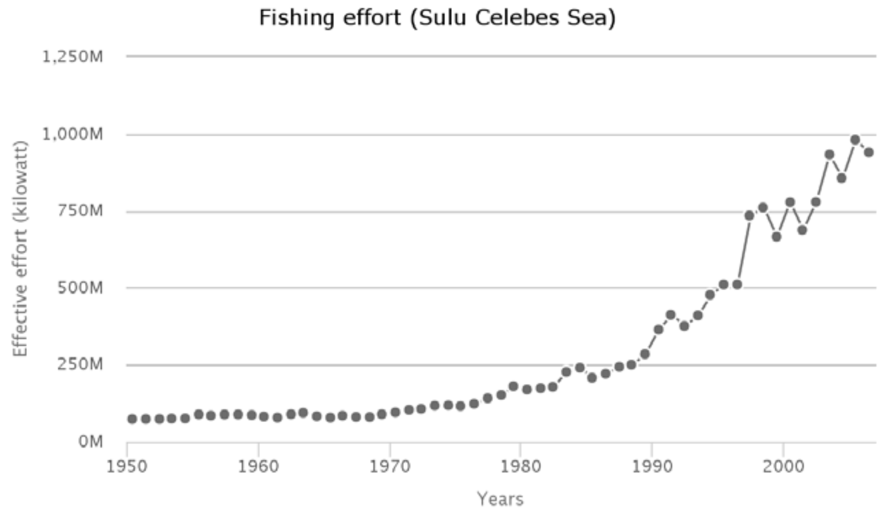
Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch decreased from 70% in the early 1950s to 12% in late 1950s. Then, this percentage fluctuated around 17% in recent decade.



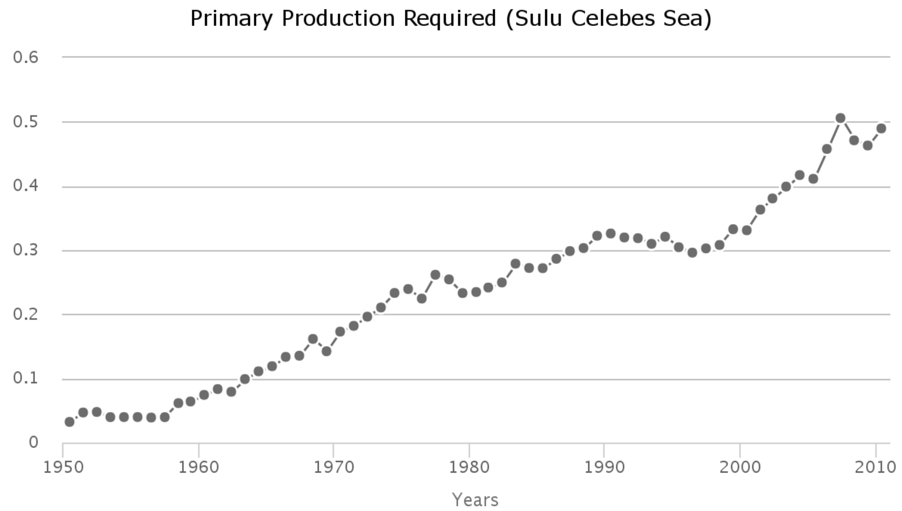
Fishing effort

The total effective effort continuously increased from around 75 million kW in the 1950s to its peak around 1,000 million kW in the mid-2000s.



Primary Production Required

The primary production required (PPR) to sustain the reported landings in this LME is increasing, and has reached 40% of the observed primary productivity 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 low (level 2 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this increased to moderate in 2030 and remained moderate in 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 was low (2). According to the Global Orchestration scenario, this increased to moderate in 2030 and remained the same in 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
2	1	2	3	1	3	3	1	3

Legend: Very low, Low, Medium, High, Very high

POPs

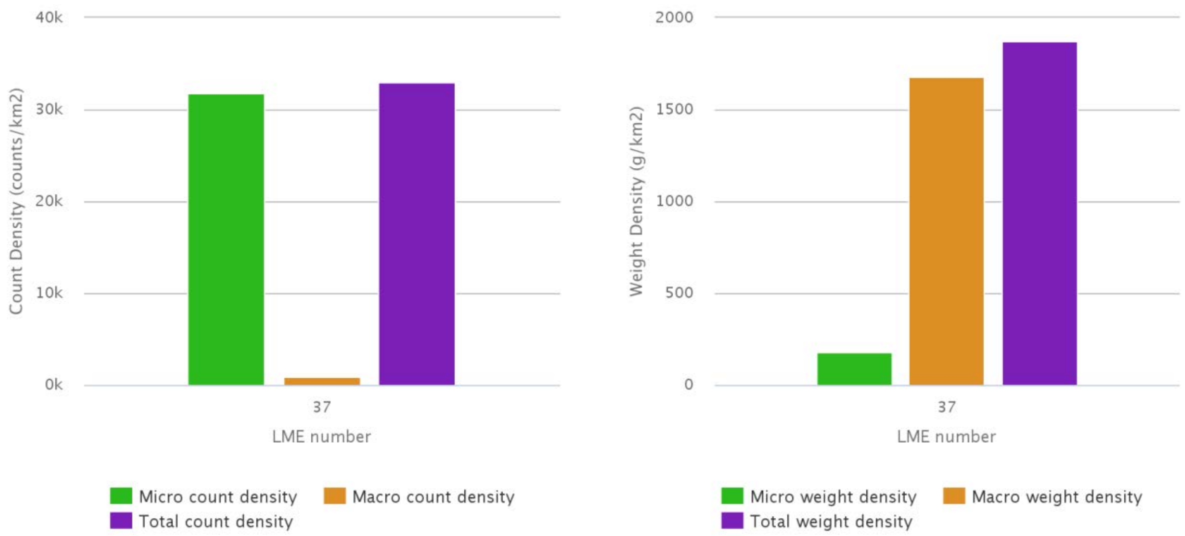
Data are available only for one sample at one location in Manila Bay. This location shows minimal concentration (ng.g-1 of pellets) for HCHs (0.4) and low concentration for DDTs (5), while moderate concentration for PCBs (140). The PCBs concentration corresponds to risk category 3 of the five risk categories (1 = lowest risk; 5 = highest risk), and is prominent among Southeast Asian countries. Based on detailed studies by analyzing surface sediments, sediment core, and air samples, current emission of PCBs was suggested (Kwan et al., 2013; Kwan et al., 2014). However, more locations should be monitored to better understand the distribution of PCBs.

	PCBs		DDTs		HCHs	
Locations	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk
1	140	**3**	5	**2**	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 very limited evidence from sea-based direct observations and towed nets to support this conclusion.



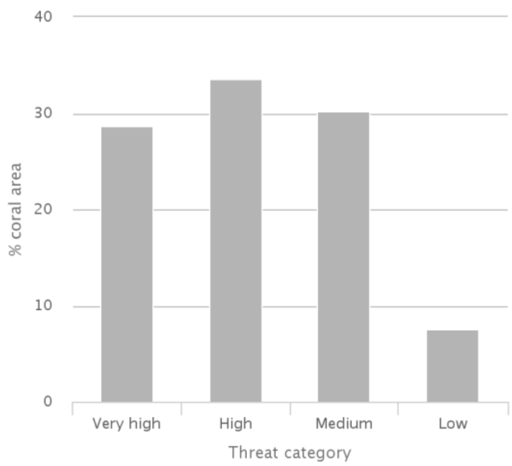
Ecosystem Health

Mangrove and coral cover

0.7% of this LME is covered by mangroves (US Geological Survey, 2011) and 1.99% 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 284. 29% of coral reefs cover is under very high threat, and 34% 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 change to 43% and 28% for very high and high threat categories respectively. By year 2030, 61% 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 62% by 2050.

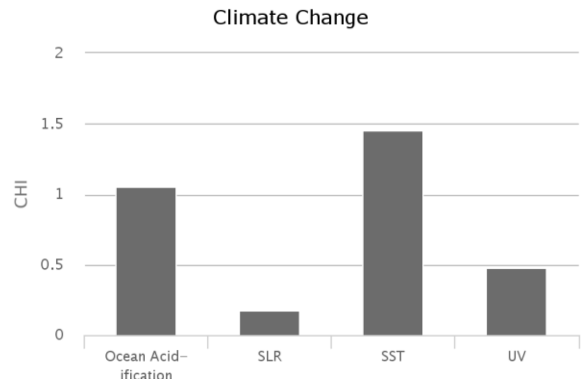


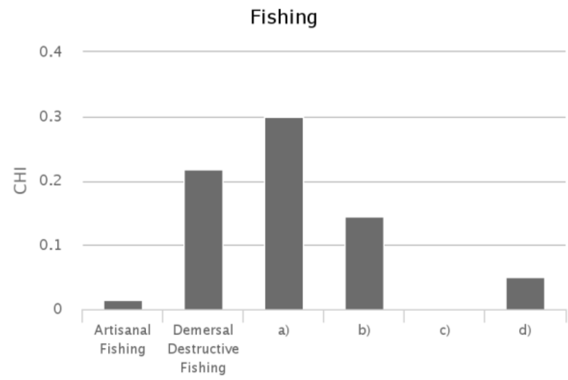
Marine Protected Area change

The Sulu-Celebes Sea LME experienced an increase in MPA coverage from 615 km^2 prior to 1983 to 27,582 km^2 by 2014. This represents an increase of 4,387%, within the medium category of MPA change.

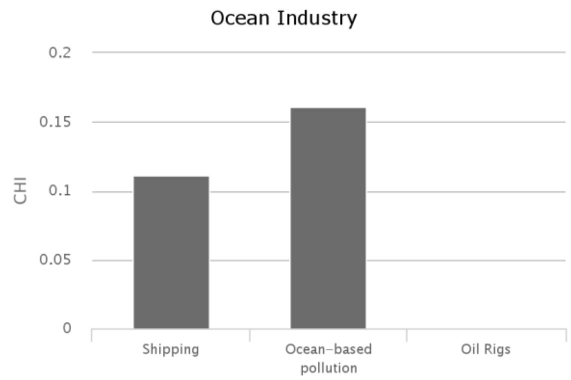
Cumulative Human Impact

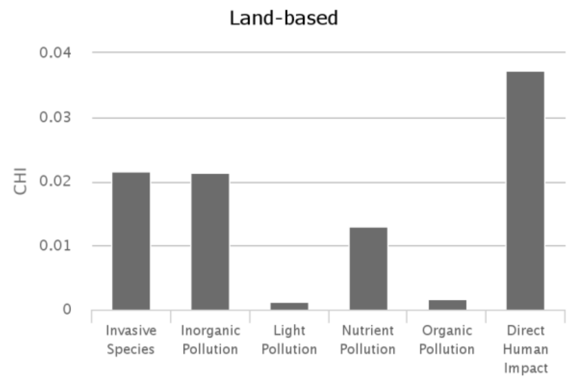
The Sulu-Celebes Sea LME experiences above average overall cumulative human impact (score 4.25; maximum LME score 5.22), which is also well above the LME with the least cumulative impact. It falls in risk category 4 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (1.05; maximum in other LMEs was 1.20), UV radiation (0.47; maximum in other LMEs was 0.76), and sea surface temperature (1.45; maximum in other LMEs was 2.16). Demersal destructive commercial fishing (0.22; maximum in other LMEs was 0.56) and demersal non-destructive high-bycatch (0.30; maximum in other LMEs was 0.60) also had high impact. Other key stressors include commercial shipping, sea level rise, ocean based pollution, pelagic low-bycatch commercial fishing, and demersal non-destructive low-bycatch commercial fishing.



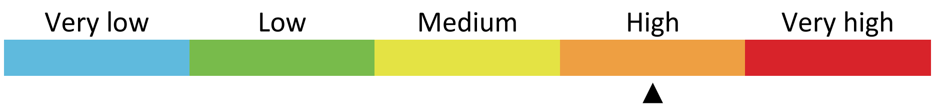


a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing





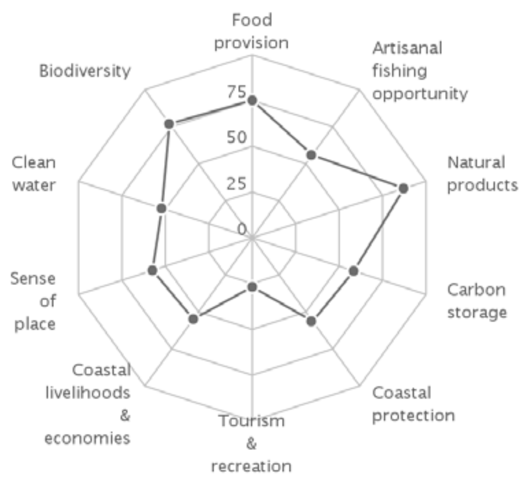
CHI: 4.25



Ocean Health Index

The Sulu-Celebes Sea LME scores below average on the Ocean Health Index compared to other LMEs (score 62 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 2 points compared to the previous year, due in large part to changes in the scores for coastal economies and clean waters. This LME scores lowest on mariculture, coastal protection, carbon storage, coastal livelihoods, 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).

Ocean Health Index (Sulu Celebes Sea)



OHI: 60.13

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 327 980 km^2. A current population of 82 399 thousand in 2010 is projected to increase to 116 545 thousand in 2100, with a density of 251 persons per km^2 in 2010 reaching 355 per km^2 by 2100. About 67% of coastal population lives in rural areas, and is projected to remain the same in share in 2100.

Total population		Rural population	
2010	2100	2010	2100
82,399,159	116,545,183	55,510,217	78,160,910

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 25% of the LME's coastal dwellers. This LME places in the very high-risk category based on percentage and in the very high-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
20,749,617

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 $1 596 million for the period 2001-2010. Fish protein accounts for 39% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$14 403 million places it in the low-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 very high risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
1,596,199,394	38.9	14,403,345,299	11.5	0.8619

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 low HDI and high-risk category. Based on an HDI of 0.657, this LME has an HDI Gap of 0.343, 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 increased population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.6574	0.8740	0.5833

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
0.8225	0.5221	0.4297	0.6419

Legend:

Very low | Low | Medium | High | Very high

Governance

Governance architecture

The two transboundary arrangements for fisheries (WCPFC and APFIC) in this LME each cover high seas highly migratory tuna and tuna-like fisheries and the fisheries within national jurisdiction. There does not appear to me 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. 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.

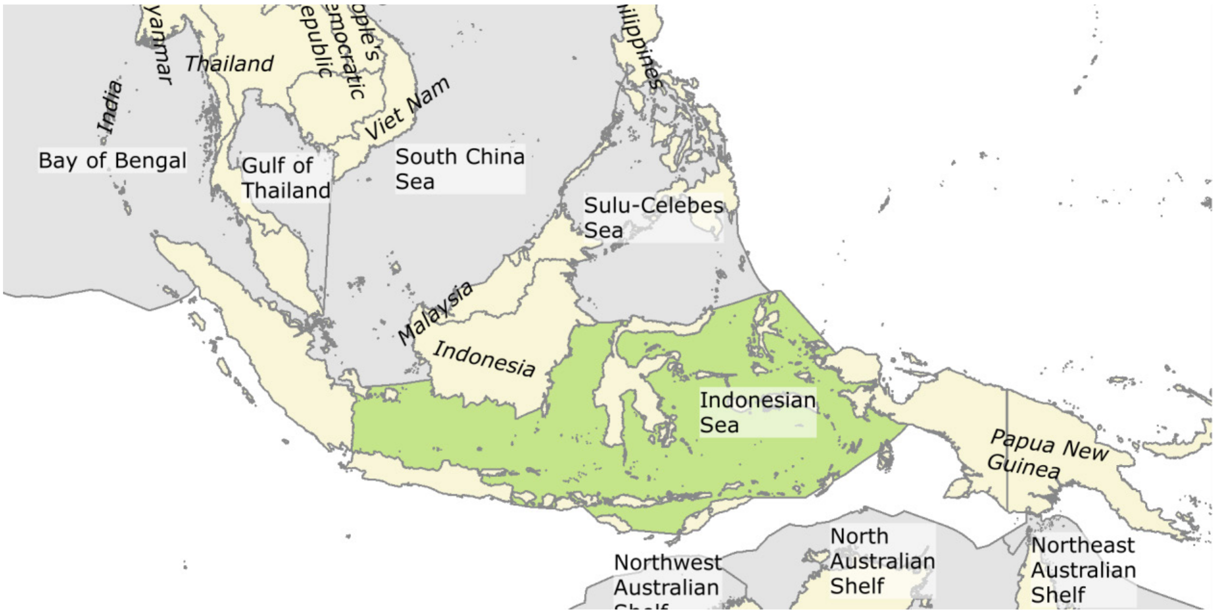
The overall scores for ranking of risk were:

Engagement	Completeness	Integration
71	50	0.1

Legend:

Very low | Low | Medium | High | Very high

LME 38 – Indonesian Sea



Bordering countries: East Timor, Indonesia
LME Total area: 2,289,597 km^2

List of indicators

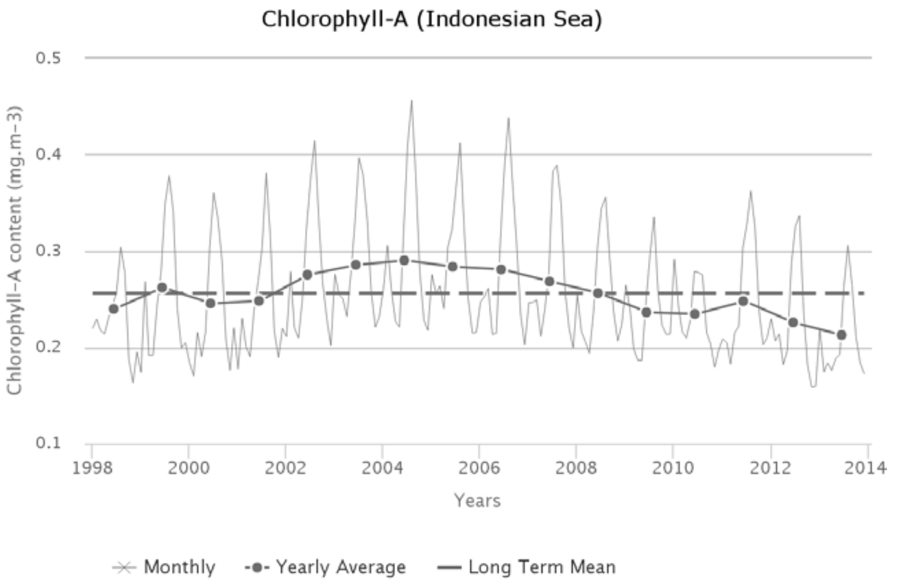
LME overall risk

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.

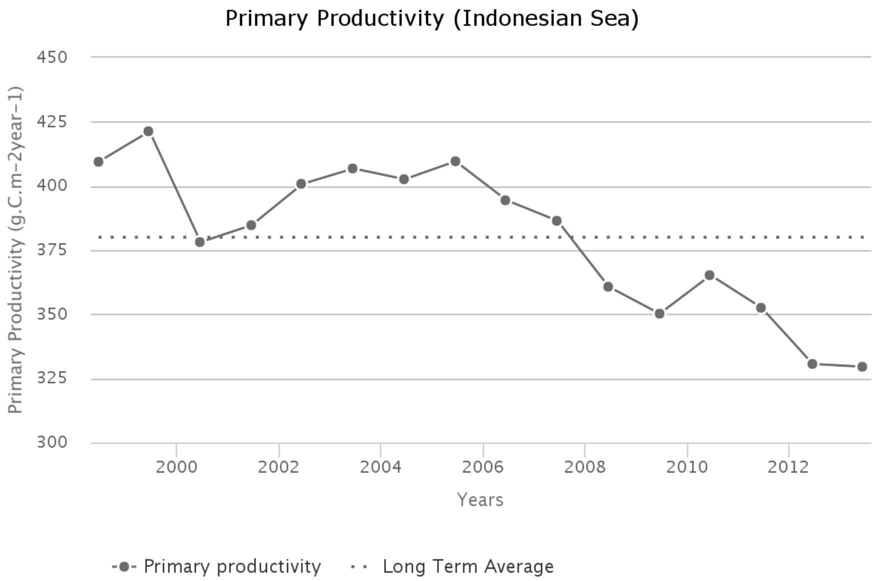
Productivity

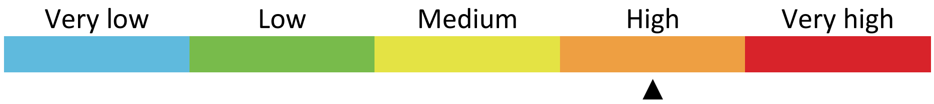
Chlorophyll-A

The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.369 mg.m^{-3}) in August and a minimum (0.205 mg.m^{-3}) during April. The average CHL is 0.256 mg.m^{-3}. Maximum primary productivity (421 g.C.m^{-2}.y^{-1}) occurred during 1999 and minimum primary productivity (329 g.C.m^{-2}.y^{-1}) during 2013. There is a statistically significant decreasing trend in Chlorophyll of -15.8 % from 2003 through 2013. The average primary productivity is 380 g.C.m^{-2}.y^{-1}, which places this LME in Group 4 of 5 categories (with 1 = lowest and 5= highest).



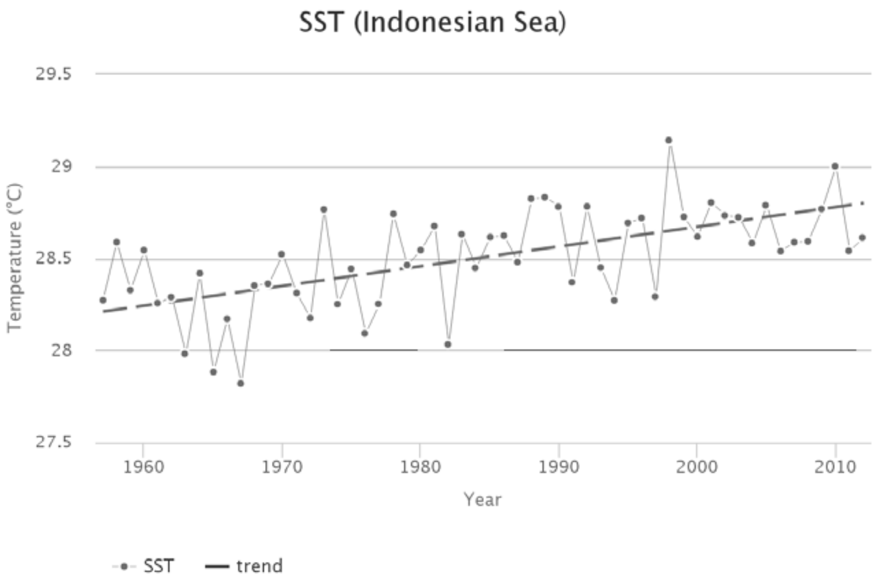
Primary productivity





Sea Surface Temperature

From 1957 to 2012, the Indonesian Sea LME #38 has warmed by 0.54°C, thus belonging to Category 3 (moderate warming LME). The thermal history of the Indonesian Sea since 1957 included a cooling epoch through 1967, when SST dropped to 27.8°C, and steady warming ever since. The all-time minimum of 1967 occurred simultaneously with the all-time minimum in the Sulu-Celebes Sea LME #37 and only a year prior to the all-time minimum of 1968 in the West-Central Australian Shelf LME #44 and a minimum of 1968 in the North-West Australian Shelf LME #45. This sequence of events can be explained by advection of the low-temperature signal of 1967 from the Indonesian Sea toward Western Australia with the Indonesian Throughflow. The 1982 minimum occurred simultaneously in the North and Northeast Australian Shelf LMEs #39-40, but not off Western Australia; this can be explained by long-time variability of circulation pattern. The 1998 all-time maximum of >29.1°C was likely caused by the El Niño 1997-98.

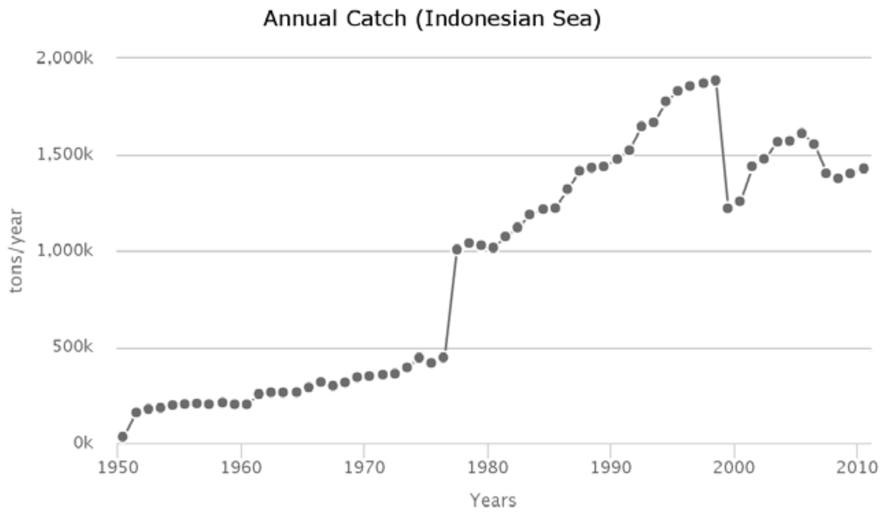


Fish and Fisheries

The fisheries of the Indonesian Sea LME are very complex and diverse. Although much of the catch comes from its artisanal sector, industrial fisheries contribute considerably more in terms of value, since they target high-value shrimp and tuna stocks. Major species caught in the LME include tuna, sardines, anchovy, mackerel, as well as a range of reef fishes. Reef fisheries are vital to subsistence fishers and their families in the region but are also important in supplying high value products for expanding international, national and local markets.

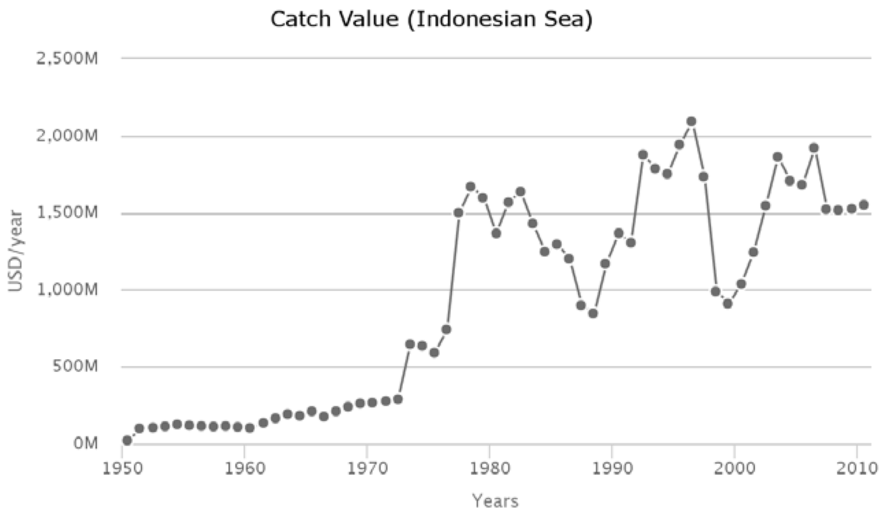
Annual Catch

Total reported landings in the LME have increased steadily from the 1950s, with a sharp increase from less than half a million t to over one million t in the mid-1970s, probably a statistical artifact.



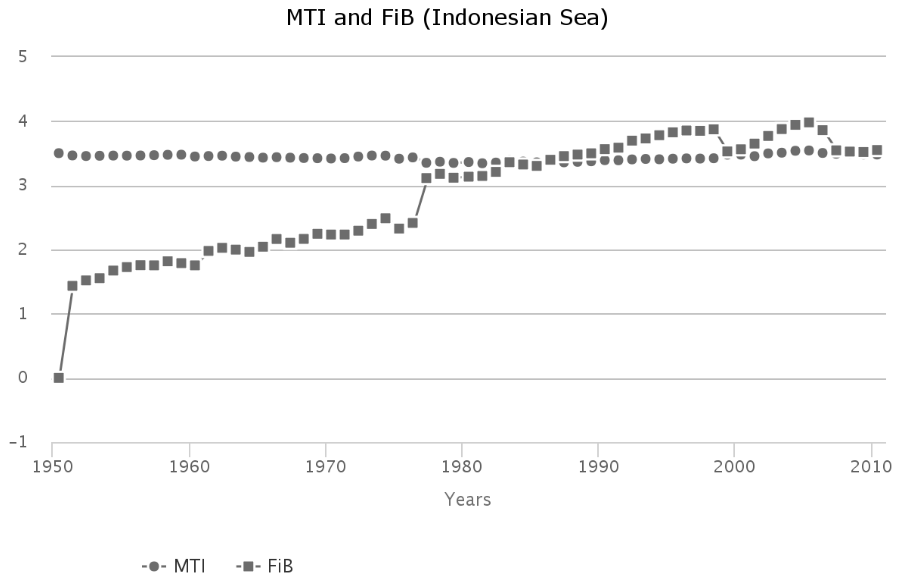
Catch value

In 1998, the total reported landings reached 1.9 million t and the value of the reported landings, showing a trend similar to landings, reached close to 2 billion US$ (in 2005 real US$) in 1996.



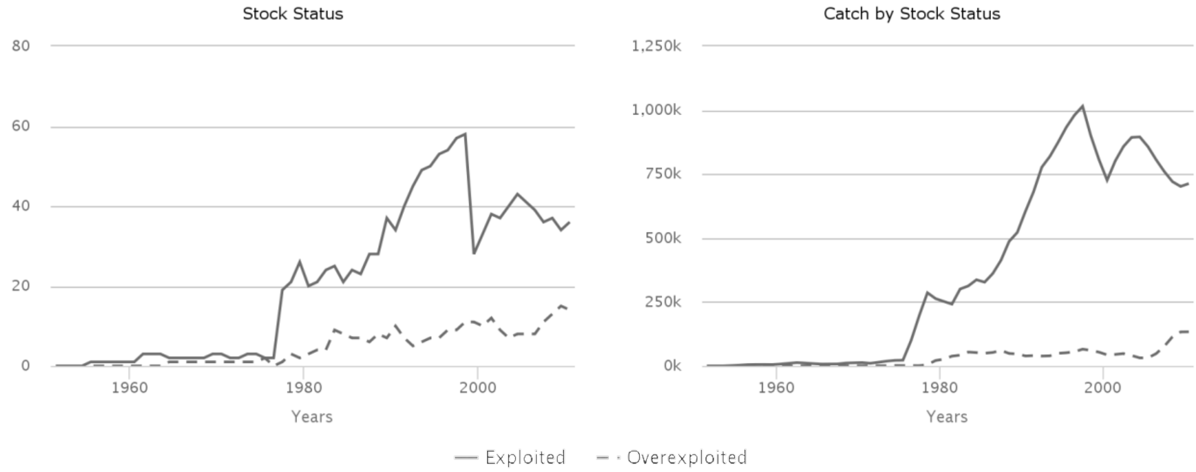
Marine Trophic Index and Fishing-in-Balance index

The MTI shows an increase from the early 1980s, due to increased landings of predatory species such as tuna. This interpretation is confirmed by the increase in the FiB index during the same period, documenting a steady expansion of the fisheries in the region. Note, however, that these indices may be skewed by the high level of unidentified fishes in the underlying landings statistics.



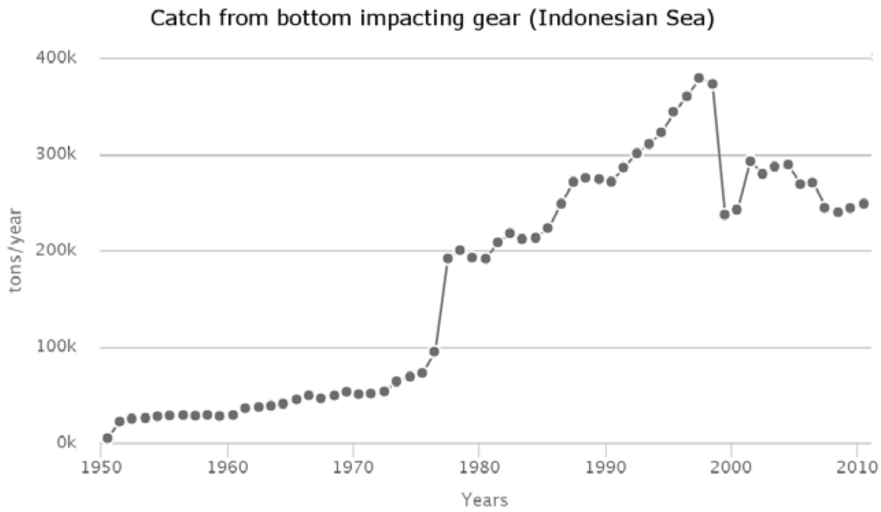
Stock status

The Stock-Catch Status Plots indicate that about 30% of the stocks in the LME are either overexploited or have collapsed, with 55% of the catch from fully exploited stocks. Again, the high level of taxonomic aggregation in the underlying landings statistics must be noted.



Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch increased from 14% in the 1950s to its first peak at around 35% in 1980. Then, this percentage kept decreasing and fluctuated between 16% and 20% in recent decade.

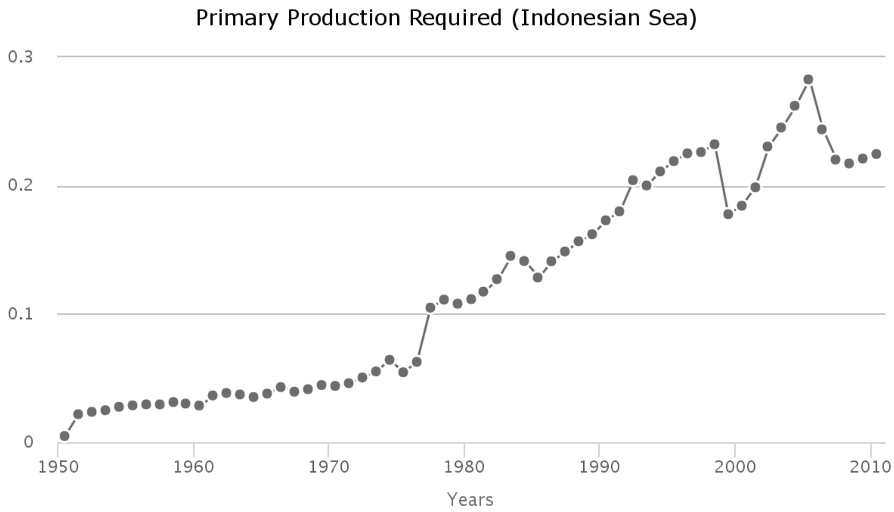


Fishing effort

The total effective effort continuously increased from around 20 million kW in the 1950s to its peak around 745 million kW in 2005.

Primary Production Required

The primary production required (PPR) to sustain the reported landings in this LME is increasing, and is currently at 30% of the observed primary production.



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 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 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	1	3	3	1	3	3	1	3

Legend: Very low, Low, Medium, High, Very high

POPs

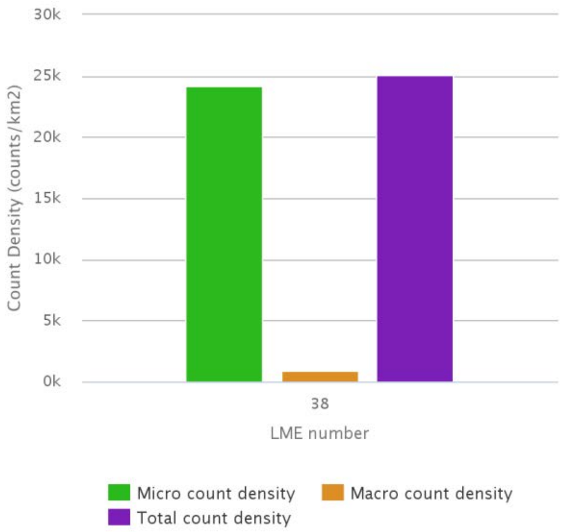
Data are available for three samples at two locations in Jakarta Bay. One was collected in 2007, while the others were collected in 2012. Extremely high average concentrations ($ng.g^{-1}$ of pellets) of PCBs (263, range 14-756) and DDTs (210, range 14-590), both corresponding to risk category 5 of the five risk categories (1 = lowest risk; 5 = highest risk) were observed in a sample collected in 2012, though minimal and low concentrations were observed in the other two samples including one collected in 2012. The average concentration of HCHs was 1.9 (range 1.1- 3.5), risk category 1. Continuous monitoring is recommended.

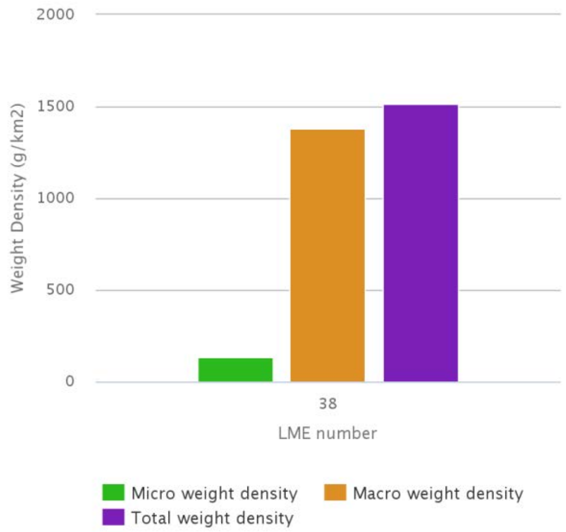
	PCBs		DDTs		HCHs	
Locations	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk
3	263	4	210	5	1.9	1

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.





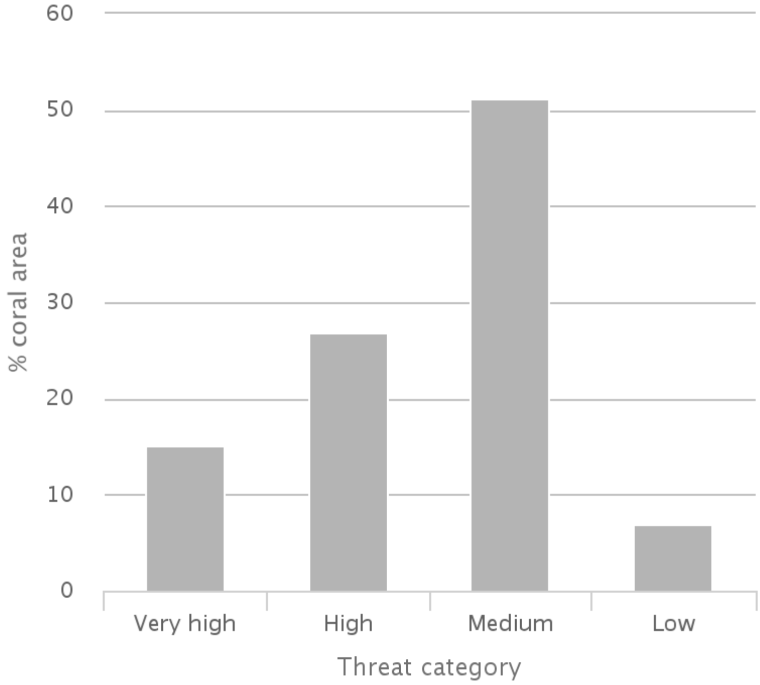
Ecosystem Health

Mangrove and coral cover

0.49% of this LME is covered by mangroves (US Geological Survey, 2011) and 1.13% 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 250. 15% of coral reefs cover is under very high threat, and 27% 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 18% and 29% for very high and high threat categories respectively. By year 2030, 34% 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 45% by 2050.

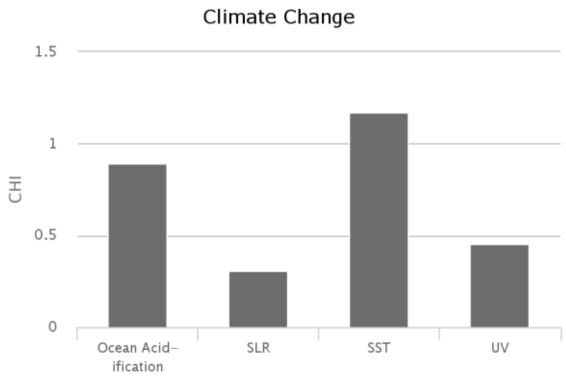


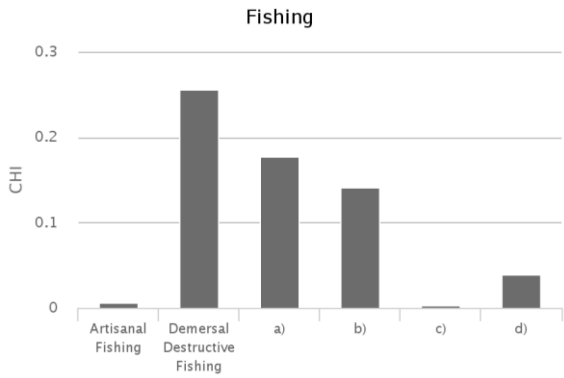
Marine Protected Area change

The Indonesian Sea LME experienced an increase in MPA coverage from 2,016 km^2 prior to 1983 to 75,423 km^2 by 2014. This represents an increase of 3,642%, within the medium category of MPA change.

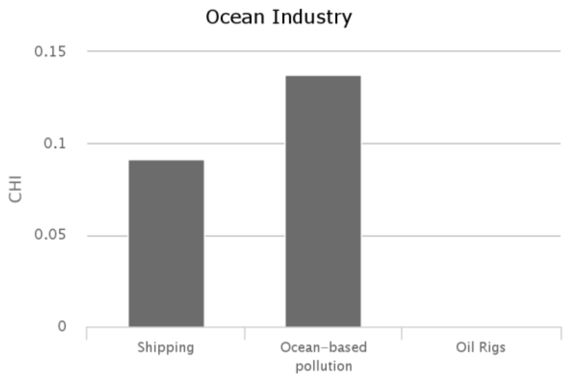
Cumulative Human Impact

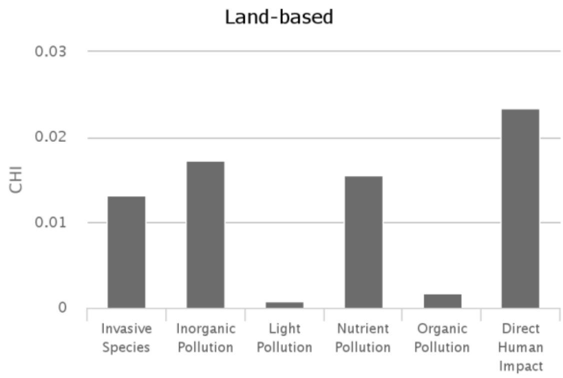
The Indonesian Sea LME experiences an above average overall cumulative human impact (score 3.75; maximum LME score 5.22), which is also well above the LME with the least cumulative impact. It falls in risk category 3 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, all four connected to climate change have the highest average impact on the LME: ocean acidification (0.89; maximum in other LMEs was 1.20), UV radiation (0.46; maximum in other LMEs was 0.76), sea level rise (0.31; maximum in other LMEs was 0.71), and sea surface temperature (1.17; maximum in other LMEs was 2.16). Other key stressors include commercial shipping, ocean based pollution, pelagic low-bycatch commercial fishing, and all three types of demersal commercial fishing (demersal destructive, non-destructive low-bycatch, and non-destructive high-bycatch).

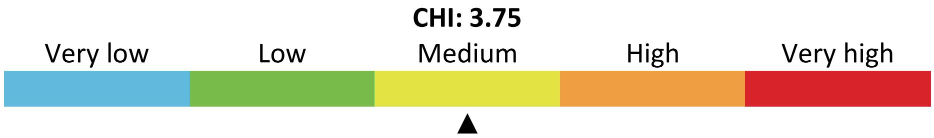




a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing

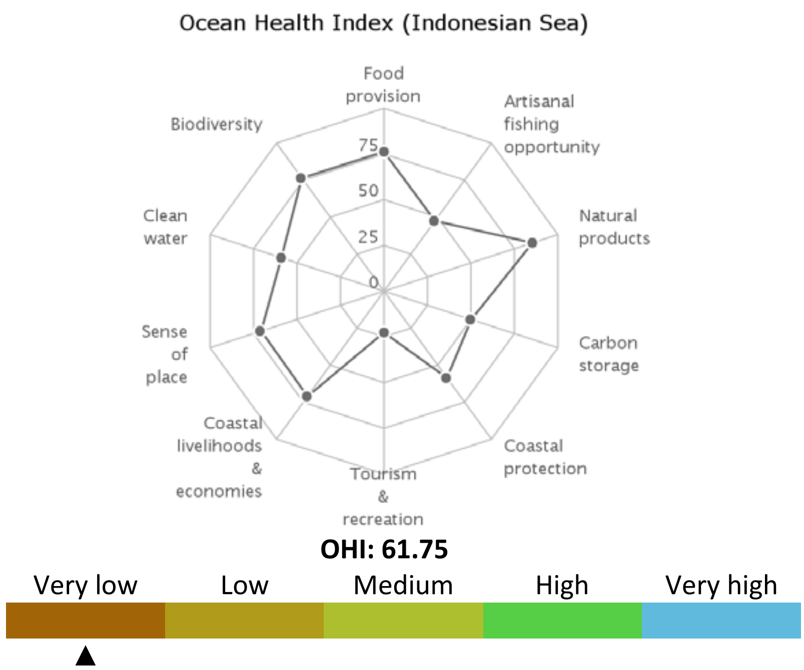






Ocean Health Index

The Indonesian Sea LME scores below average on the Ocean Health Index compared to other LMEs (score 67 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 mariculture, coastal protection, carbon storage, coastal livelihoods, tourism & recreation, and iconic species goals and highest on artisanal fishing opportunities and coastal economies 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 756,153 km^2. A current population of 172 294 thousand in 2010 is projected to increase to 242 699 thousand in 2100, with a density of 228 persons per km^2 in 2010 reaching 321 per km^2 by 2100. About 58% of coastal population lives in rural areas, and is projected to decrease in share to 56% in 2100.

Total population		Rural population	
2010	2100	2010	2100
172,293,928	242,699,415	100,139,797	137,086,093

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
23,807,269

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 $1 912 million for the period 2001-2010. Fish protein accounts for 54% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$53 153 million places it in the 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 high risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
1,912,412,118	54.2	53,152,730,017	10.5	0.8242

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 low HDI and high-risk category. Based on an HDI of 0.675, this LME has an HDI Gap of 0.325, 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 increased population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.6753	0.8873	0.4904

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 high-risk (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 risk under a fragmented world development pathway.

2010		2100	
Climate Threat	Contemporary Threat	SSP1	SSP3
0.7432	0.5087	0.4213	0.6934

Legend:

Very low Low Medium High Very high

Governance

Governance architecture

In this LME, there are three transboundary arrangements for fisheries, one each cover high seas highly migratory tuna and tuna-like fisheries in the Western Central Pacific (WCPFC) and the Indian Ocean (IOTC) and the remaining arrangement (APFIC, FAO) covers the fisheries within national jurisdiction. There does not appear to be any formal connection between the three arrangements, possibly as they have different areas of competence. However, it is to be expected that at some high level, the two Commissions (WCPFC and IOTC) for the large highly migratory fisheries would connect. In contrast, 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 the "within national jurisdiction" arrangements for fisheries or pollution/biodiversity appears to be integrated with the other or with the tuna arrangements. The specific biodiversity arrangement for turtles (IOSEA) does not appear to be integrated with any of the other arrangements in the LME. Further, 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 other intergovernmental partnerships or with each other's meetings, but this appears to be informal.

The overall scores for ranking of risk were:

Engagement	Completeness	Integration
56	52	0.1

Legend:

Very low Low Medium High Very high

UNEP-DHI PARTNERSHIP
Centre on Water and Environment

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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: Southern and Southeastern Asia - Annex I -- 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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United Nations Environment Programme
P.O. Box 30552 - 00100 Nairobi, Kenya
Tel.: +254 20 762 1234
Fax: +254 20 762 3927
e-mail: publications@unep.org
www.unep.org

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