CRBOM Small Publications Series No. 13

Examples of how to describe a river basin

by

Dennis Von Custodio

Center for River Basin Organizations and Management,
Solo, Central Java, Indonesia

December 2009

The *'Small Publications'* are intended for knowledge-sharing and dialogue. In some cases they may present facts, information and lessons learnt. In other cases, they provide news, opinions, ideas or open questions for discussion.

They express the opinions of the author(s) and not those of CRBOM.

They can be freely copied and disseminated.

Contributions are most welcome - in English or in Bahasa Indonesia.

The author:

Dennis Von Custodio,
IWRM specialist, dvcustodio.consultant@adb.org

CRBOM
Center for River Basin Organizations and Management,
Solo, Central Java, Indonesia
www.crbom.org
info@crbom.org

Contents

Appendices

Summary

This paper provides examples of ways to describe, monitor and analyse river basins.

The demand of data and information varies from one context to another. Different river basins have different development agendas and different management needs and options. For a specific application, the operation of a dam or an irrigation system requires a decision basis that is different from what is needed for a strategic development plan, a feasibility study or an impact assesment.

In general, decision-makers prefer condensed information, with a few key indicators - knowledge rather than data - and suited for a clear course of action. In comparison, technical staff and scientists tend to prefer much more detailed information and a large number of indicators - data as well as knowledge.

Acknowledgement

The paper draws comprehensively on work by Kei Saiki conducted during an internship at ADB, which in turn was supported by professor Toshio Koike, University of Tokyo, Civil Engineering Department, and Christopher I. Morris, Senior Water Resources Specialist in ADB's SEAE Division, as well as other members of ADB's Water Team.

Acronyms and abbreviations

BOD:	Biological oxygen demand (mg oxygen/l); BOD5 is the biological oxygen demand determined over a 5-days period
COD:	Chemical oxygen demand (mg oxygen/l)
DO:	Dissolved oxygen (mg oxygen/l)
GWP:	Global Water Partnership
IWRM:	Integrated water resources management
LLDA:	Laguna Lake Development Authority (Philipppines)
NARBO:	Network of Asian River Basin Organizations
RBC/RBO:	River basin committee/river basin organization
WWAP:	World Water Assessment Programme

Glossary

Chlorophyll: The green pigment in plants and algae (and some bacteria), conducting photosynthesis (using sunlight for primary production, converting carbon dioxide and water into organic carbon - and producing oxygen as a *'waste product'* in the process). Photosynthesis converts 100,000,000,000 t of carbon into biomass per year - six times the global energy consumption[1] - and is an absolute necessity for life on Earth; but excessive primary production can damage water bodies by oxygen depletion caused by the subsequent decay of the produced organic matter, as well as oxygen consumption by the algae during the night

Composite index/indicator: An derived index/indicator that combines several primary indices/indicators. Example: UNDP's Human Development Index (HDI) is the average of indicators for life expectancy, education, and per capita purchase power parity. A Water Poverty Index (WPI) proposed by Lawrence et al (Oct 02) combines 27 individual indicators of water availability, acces to water, water uses, and the aquatic environment. A related example is the Index of Drinking Water Adequacy (IDWA) developed for the purpose of ADB's Asian Water Development Outlook, combining 5 indicators of water availability, quality, and access

Data, knowledge, information: Sometimes a useful distinction can be made between (i) data: Quantities, produced by observations, recordings or surveys, identified in time and place, and expressed in clearly defined units (example: A rainfall); (ii) knowledge: Understanding of dependencies and cause-effect relationships (example: A rainfall-runoff relationship); and (iii) information: Processed data, perhaps averaged over time and/or over an area, perhaps related to a standard or a reference level, and perhaps involving estimates and conversions (example: A predicted flood expected to exceed a danger level)

DPSIR (driving forces, pressures, state, impact, response) framework: A sequence of related characteristics that, between them, describe the conditions in a river basin (or a country or some other system), with a particular view to human interventions, applied by for example the World Water Assessment Programme and the EU

Eutrophication: Excessive occurrence of nutrients in a water body, resulting in a high primary production. Eutrophication can have negative environmental effects, such as large fluctuations of dissolved oxygen between night and day, or damage to benthic ecosystems due to shading by algae

Governance of natural resources is a public management process, possibly based on legislation, an institutional framework, and policies and practices. *'Good governance'* can from case to case be characterised by predictability, transparency, sustainability, value generated, accountability, participation and social balance

IWRM (integrated water resources management) (as defined by Global Water Partnership): A process which promotes the co-ordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems

---

[1] Wikipedia

1 Introduction

A river basin can be described in many ways, depending on its characteristics and on the purpose of describing it. In one basin, an important characteristic can be the number of households with access to safe water; in another, the coverage of irrigation infrastructure; and in yet another, the quality of aquatic habitats and ecosystems.

This paper presents some general thoughts on basin-level data and information, illustrated by specific examples.

The topic is closely related to the more governance-oriented disciplines of IWRM implementation monitoring and RBC/RBO benchmarking, which are comprehensively covered by work completed and in progress by ADB, NARBO and others.

2 Basin-level data and information

Basin-level data and knowledge can contribute to

- decision support in general and the basis for investment planning in particular;
- specific feasibility studies and impact prediction;
- inter-basin knowledge-sharing and collaboration; and
- public awareness-building, in turn contributing to participation in and support to good basin governance.

These purposes can be supported by once-off assessments, like a state-of-the-basin report. The value will often be more powerful, however, if a continuous monitoring is conducted, providing information not only about the level of various indicators, but also about the related trends - whether things are moving in the right direction - a bit like a company monitors its accounts.

In this connection there is a need of a delicate balance between comprehensiveness and complexity. One the one hand, the applied set of indicators should cover all important aspects. One the other hand, each indicator should be as transparent as possible, the set of indicators should be as simple as possible, and the number of indicators as small as possible.

3 Context and rationale

A distinction can be made between a river basin *as it is,* and the management of the river basin (for example by an RBC/RBO). The good purpose of improving a river basin is not identical with the (also good) purpose of improving an RBC/RBO - although the two can be closely related. The river basin *as it is* reflects natural conditions (for example rainfall and drought risk) and completed developments (for example of infrastructure and storage capacity) and interventions (for example land use and sewage discharges). This is then the starting point for continued basin-level development and hereby the origin of a set of challenges to the basin-level management.

In the long term, the aspects will converge, as far as good basin management practices will contribute to good conditions in the basin. The conditions (and their gradual improvement) represent the end while the management practices represent the means. That management practices improve in the course of time is much better than the alternative; and the ability to generate change can be an important performance characteristic of a development-oriented RBC/RBO; but the hard evidence of success is improvements in the basin itself.

Table 1: IWRM-related assessment perspectives (national level and basin level)

Social aspects	Population - urban and rural
	Income distribution, poverty incidence
	Access to safe water and sanitation (and electricity)
	Water-borne diseases
Economy	Land use
	Water-dependent production systems: Performance, efficiency, income generation, livelihood generation
	Hydropower potential and utilization
	Other water-related assets
Water resources	Water availability (including seasonality)
	Water demand
	Actual water use (as limited by availability and infrastructure)
Calamities	Drought, inland floods, landslides, coastal floods: Risk, exposure, vulnerability
Infrastructure	Water supply and sanitation
	Irrigation infrastructure
	Storage capacity
	Waterways
Environment	Sewage and solid waste generation and disposal
	Use of pesticides
	Habitats and ecosystems
	Water quality
	Erosion, siltation, saline intrusion

Note: This table does not include several important social aspects (general health, education, social shocks) because they are considered as being not directly water-related. They will interact with the water-related ones, however

Table 2: IWRM-related governance/management assessment perspectives

National level	Institutional landscape; tasks and performance of government bodies Water resources apex body for inter-agency coordination? Inter-sector coordination modalities (including national strategic planning) Water law? Water defined as a public good? Environmental regulation and enforcement Decentralization, public participation Public services: Weather forecasts, etc. Disaster preparedness ... etc.
Basin level	RBC/RBO? RBC/RBO tasks, mandate and performance Knowledge base and information flows Planning ... etc.

Indicators for national IWRM implementation have been developed by ADB, GWP and others, while specific indicators for RBC/RBO performance have been developed by NARBO.

Another distinction can be made between the national level and the river basin level. (Also, an international level may relate, for shared river basins; and there are important scheme-level and farm-level management levels below the basin level).

The tables above list some *'assessment perspectives'* (or *'characteristics',* or, for that sake, *'meta-indicators)'* that are (in broad general) applicable to countries and river basins. Each of them can represent a whole set of individual indicators. For a specific river basin, only a sub-set would be relevant.

The context is illustrated in the diagramme below, which shows the hierarchy between IWRM foundations, approach, and goals. The goals are represented by the social, economic and environmental conditions in the river basin.

Figure 1: Hierarchy and structure of IWRM elements

Source: Kei Saiki (Jan 08)

4 Examples

4.1 Healthy Waterways, South East Queensland

http://www.healthywaterways.org/

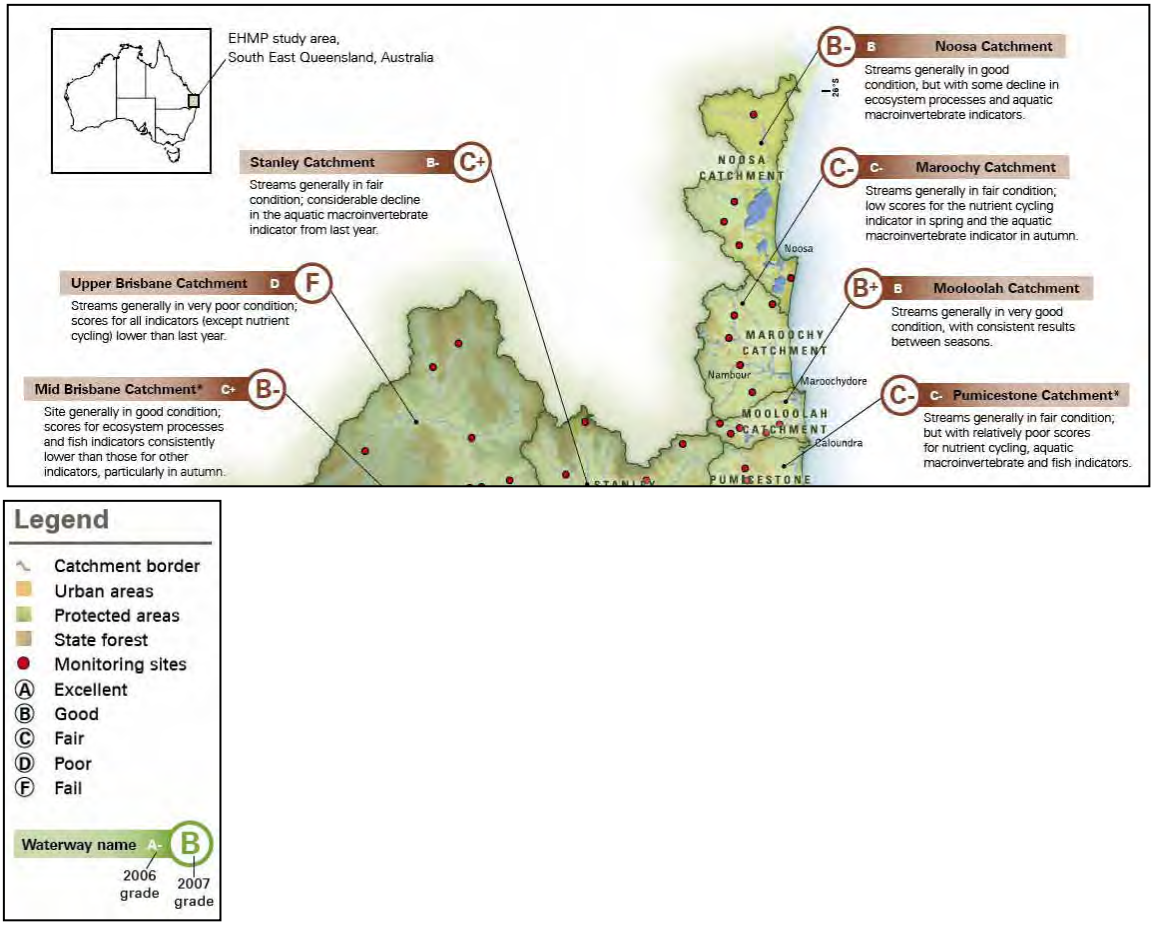
The South East Queensland Healthy Waterways Partnership is a collaboration between the Queensland Government, local governments, industries, research organisations and community groups. The partners work together to improve the management of catchments and the health of the waterways.

An environmental monitoring is conducted, consisting of 5 elements: Physical and chemical water quality; nutrients; ecosystem processes; macro-invertebrates; and fish. Each element has 2 to 3 sub-indicators whose results are combined into a score.

Since 1999, the Ecosystem Health Monitoring Program has produced an annual Ecosystem Health Report Card. The Report Card presents an easy-to-understand snapshot of the health of the region's freshwater and estuarine/marine environments, providing *'A'* to *'F'* ratings for 18 catchments, 18 estuaries, and Moreton Bay.

The 2007 Report Card compiles data from 381 freshwater and estuarine/marine sites from July 2006 to June 2007. [2]

Figure 2: Ecosystem Health Report Card 2007 (extract)



[2] Report cards from 2008 and 2009, in a different format, are available from the Internet

4.2 Laguna de Bay

www.llda.gov.ph

Laguna de Bay, located east of Manila, with its 900 km2 surface area, is the biggest lake in SE Asia. It drains through Metro Manila and into Manila Bay via the 25 km long Pasig River. The water level in the lake varies between the level of the sea in the dry season and 2 m above sea level in the rainy season. In the course of the dry season, the flow in the river becomes stagnant, and there is even a fairly regular annual event (with a duration of some weeks) of reverse flow of saline water from the sea through the river into the lake, which hereby becomes brackish for a period of time. The lake and (particularly) the river are exposed to severe pollution. The drainage basin of the lake is subject to diverse stakeholder interests, including fisheries and small-scale cultivation on the shallows when the water level is low.

The Laguna Lake Development Authority (LLDA) was established in 1966 for the sake of water resources management of the lake and its drainage basin. Since 1993, the agency has been placed under Department of Environment and Natural Resources (DENR).

LLDA has undertaken water quality monitoring by in-house capacity since the early 70-ies. The monitoring covers the following 4 over-all aspects and 13 well-defined indicators:

- Oxygen and oxygen demand: BOD5, COD and DO;
- bacterial pollution: Total coliforms and fecal coliforms;
- nutrients and eutrophic level: Dissolved nitrogen, phosphate, chlorophyll-A and phytoplankton; and
- hazardous substances: Oil and grease, lead, chromium and cadmium.

The data are converted into suitability classes - each class represented by a colour:

- A: OK for public water supply
- B: OK for recreation
- C: OK for fisheries, recreation and industrial water supply
- D: OK for agriculture, irrigation, livestock watering and industrial water supply

Results are shown by sub-area in a so-called Mondriaan diagramme (named after a Dutch painter who used simple shapes and clear colors), and are published on the LLDA website.

The results are presented by location, indicator and month. It would not be difficult to compile for example the over-all suitability at each location (determined by the lowest suitability level among all indicators), or the annual median level for each indicator.

Figure 3: Mondriaan diagrammes of the Laguna Lake Region

Left: COD; right: chlorophyll-A; Nov 08

Each field in the diagrammes represents a sub-area of the drainage basin

Source: LLDA website

4.3 The Lower Mekong Basin

www.mrcmekong.org

The Lower Mekong Basin covers parts of Cambodia, Laos, Thailand and Viet Nam. The Mekong River Commission (MRC), an inter-government coordination body, was formed by these countries in 1995, building on a collaboration under the Mekong River Committee that was formed in 1957.

Over the years, the MRC Fisheries Programme has produced convincing documentation of the high socio-economic value of inland capture fisheries in the basin, a knowledge that had hitherto *'passed under the radar'* of routine monitoring and official statistics; nobody was aware that this sector actually produced 2-3 mio. t/year with a value of close to 2 bio. USD/year, hereby providing livelihoods for more than a mio. people. [3]

The basin is exposed to fairly regular seasonal floods, which appear as beneficial or detrimental, depending on their timing and magnitude. MRC operates an operational flood forecasting service that is widely used for a variety of purposes, including irrigation system operation, in addition to the occasional need of emergency preparedness.

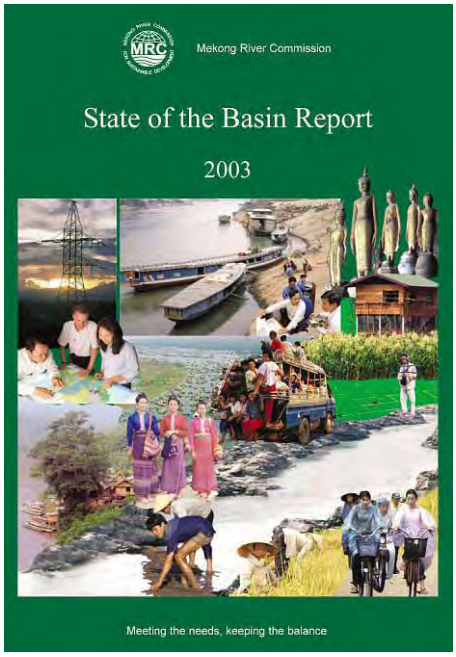
In June 2003, MRC published a comprehensive state-of-the-basin report, covering

- physical landforms;
- climate, water balance, water quality;

---

[3] Figures for the Lower Mekong Basin according to Nicolaas van Zalinge et al (Feb 03): The Mekong River System. 2nd International Symposium on the Management of Large Rivers for Fisheries, Phnom Penh

- habitats and ecosystems;
- population and population dynamics;
- social development, including access to water, sanitation and electricity; and livelihoods, income and poverty;
- macroeconomics (by country);
- capture fisheries and aquaculture;
- agriculture and forestry, land use, environmental implications, land tenure issues, other resource-based livelihoods;
- hydropower;
- trade and transport, including inland waterways transport;
- domestic water and sanitation;
- floods, including climate change, land degradation, and environmental benefits of floods;
- trends, hot spots and trans-boundary issues; and
- regional cooperation.



This report was a once-off exercise, largely drawing on secondary data. It was custom-made in support of the specific development agenda at the time. Subsequently, it has been proposed to conduct a continuous monitoring process, drawing on a network of institutional *'informants'* (which is in place and operational, via the national Mekong Committees), to be published on the Internet (and printed occasionally, according to demand).

4.4 The Murray-Darling Basin

www.mdba.gov.au

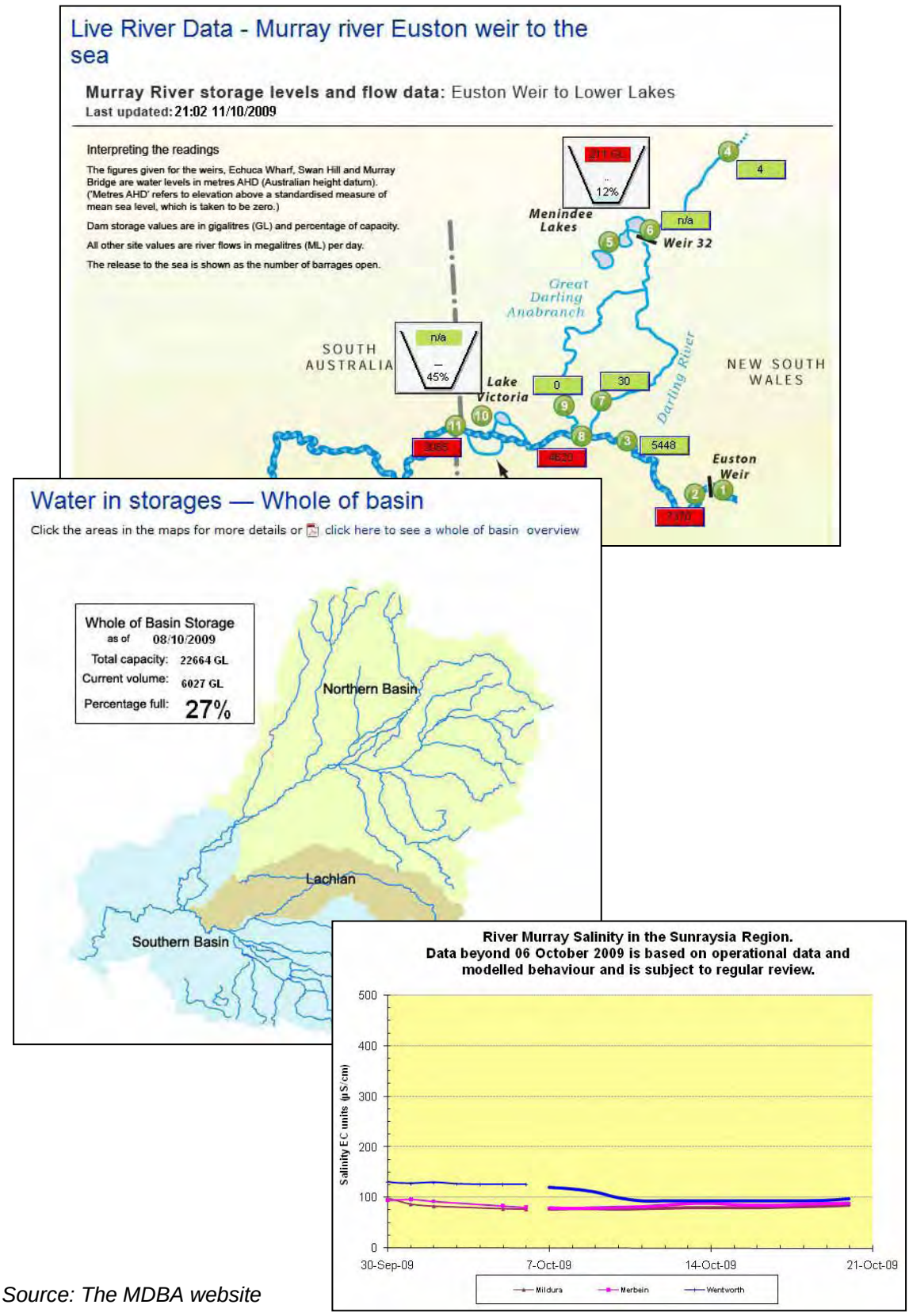
The Murray-Darling basin (1,061,469 km2) covers parts of the Capital Territory, New South Wales, Queensland, South Australia, and Victoria. The basin is water-poor but is intensely cultivated and irrigated. Its storage capacity (of around 35 km3) roughly equals the annual runoff.

The Murray-Darling Basin Authority (MDBA) was formed in December 2008, replacing the Murray-Darling Basin Commission (MDBC) established in 1988. Its origin is based on a delicate inter-state water-sharing dialogue that goes back for more than a century, exemplified by the original River Murray Waters Agreement from 1915.

One of the main tasks of MDBA is to prepare a basin plan for withdrawals of groundwater and surface water. MDBA is also involved in policy advice, monitoring, and knowledge-building. Much of the water-related development is managed at the state level or the central government (or Commonwealth government) level.

Given the water scarcity, there is an evident demand of information about flows, storage volumes and salinity (in the lower reaches). The MDBA website provides this information, as illustrated below.

Figure 4: Real-time information about flow, storage and salinity



Source: The MDBA website

4.5 The World Water Assessment Programme

www.unesco.org/water/wwap/

The World Water Assessment Programme (WWAP) applies indicators for its World Water Development Reports.[4] [5] These indicators relate to the country level. As argued above, however, there are few and small general differences between the country level and the basin level regarding state indicators (while the difference is visible when it comes to governance indicators).

The WWAP indicators have evolved in the course of time. The 3rd World Water Development Report (2009) lists 58 indicators, divided into 11 topics, down from 65 indicators under 12 challenge areas applied in connection with the 2nd report.[6]

The indicators are listed in Appendix A. Some of them describe the state of water resources and water-related circumstances, while others are management-oriented - particularly those under the headings of governance; settlements; valuing and charging for the resource; and knowledge base and capacity.

The indicators appear as a mix of very detailed and very general ones. Some ordinary (and important) IWRM-related indicators are missing or are hidden in composite indices: Water demand (domestic, agricultural, industrial); floods and drought; and biodiversity.

5 Discussion

Just like the demand of water varies from one context to another (and from one basin to another), so does the demand of data and information. The operation of a dam or an irrigation system requires a decision basis that is different from what is needed for a strategic plan or for a feasibility study.

Depending on the purpose of the analysis, it can make sense to distinguish between the basin *'as it is'* and the management/governance of the basin. Is the analysis conducted to identify, predict or characterize a need of intervention? Or is it conducted to assess the response?

This distinction is illustrated in the figure below.

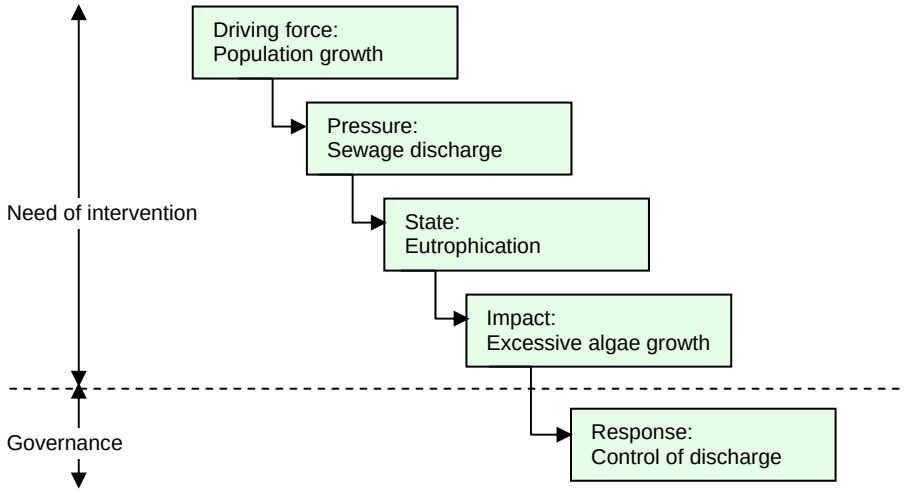
---

4 Three such reports have been published: Water in a changing world (2009); Water: A shared responsibility (2006); and Water for people, water for life (2003)

5 According to the WWAP website, *'the United Nations World Water Development Report, released every three years in conjunction with the World Water Forum, is the UN's flagship report on water. It is a comprehensive review that gives an overall picture of the state of the world's freshwater resources and aims to provide decision-makers with the tools to implement sustainable use of our water'.*

6 The indicators are not tabulated, neither in the publication itself nor on its website, but many of them are available from other websites

Figure 5: Management needs and response



Based on EU (2003), Figure 2.3, p. 14

6 Bottom line

A good knowledge base is valuable for water-dependent production systems, and for timely identification of trends and pressures.

Prediction of benefits and impacts, an important management task, depends on the coverage and quality of data and knowledge.

Interviews conducted by Kei Saiki [7] showed a clear tendency: Decision-makers prefer summarized information, with a few key indicators - knowledge rather than data - while technical staff and scientists prefer much more detailed information and a large number of indicators - data as well as knowledge.

This reflects the use of the information. Policy formulation and strategic planning focus on the bottom line and the entire basin - whether a course of action is useful, practical and sustainable - whereas feasibility and impact studies require much more detailed and perhaps more site-specific information.

Also, perhaps, this is a circumstance to keep in mind when scientists and technical specialists prepare data for presentation to decision-makers.

---

[7] Kei Saiki (Jan 08)

References

CapNet (Jun 08): IWRM for river basin organisations. Training manual

EEA (Sep 00): Questions to be answered by a state-of-the-environment report. Technical report 47, European Environment Agency

EU (2003): Analysis of pressures and impacts. Guidance Document No 3 for the Common Implementation Strategy for the Water Framework Directive (2000/60/EC)

Kei Saiki (Jan 08): A design of an IWRM basin performance benchmarking program. MSc thesis, Civil Engineering Department, University of Tokyo

Lawrence, Peter, Jeremy Meigh and Caroline Sullivan (Oct 02): The Water Poverty Index - an international comparison. Keele Economics Research Papers. Department of Economics, Keele University, UK

MRC (Jun 03): State of the basin report 2003. Mekong River Commission

Taylor, Paul (Jun 08): Indicators. Implementing IWRM at river basin level. CapNet and UNDP

UNDP (Sep 03): Indicators for monitoring the Millennium Development Goals: Definitions, rationale, concepts and sources

WWDR3 (Mar 03): The UN World Water Development Report 3: Water in a changing world. World Water Assessment Program and UN-Water, published by UNESCO. Additional information available at the UNESCO website: www.unesco.org/water/wwap/wwdr/

WWF (Jun 08): Indicators of IWRM success – a WWF checklist. Worlwide Fund for Nature, www.panda.org/freshwater

Appendix A: WWAP indicators

Source: WWDR3, Appendix 1, authored by Mike Muller, compiled by Engin Koncagül and Akif Altundas

Please refer to www.unesco.org/water/wwap/wwdr/wwdr3/indicators for definitions and explanations

Topic	***Indicator***	***Category***	***Note***
a		*b*	
Level of stress on the resource	Index of non-sustainable water use	Driving force, pressure, state	
	Rural and urban population	Pressure, state	
	Relative Water Stress Index	Pressure, state	
	Sources of contemporary nitrogen loading	Pressure, state	
	Domestic and industrial water use	Pressure, state	*c*
	Impact of sediment trapping by large dams and reservoirs	Pressure	
	Coefficient of variation for the Climate Moisture Index	State	
	Water Reuse Index	Pressure, state	
Governance	Access to information, participation and justice	Response	
	Assessing progress towards achieving the IWRM target	Response	
Settlements	Index of performance of water utilities	State	
	Urban water and sanitation governance index	State	
	Slum profile in human settlements	Pressure	
State of the resource	Total actual renewable water resources	State	
	Precipitation	Driving force	
	Total actual renewable water resources per capita	State	
	Surface water as share of total actual renewable water resources	State	
	Overlap as share of total actual renewable water resources	State	
	Inflow from other countries as share of total actual renewable water resources	State	*d*
	Outflow to other countries as share of total actual renewable water resources	State	
	Total use as share of total actual renewable water resources	State	*e*
	Groundwater development as share of total actual renewable water resources	State	
Ecosystems	Fragmentation and flow regulation of rivers	State, impact	
	Dissolved nitrogen (nitrates + nitrogen dioxide)	State	
	Trends in freshwater habitat protection	State, response	
	Freshwater species population trends index	State	
Health	Disability-adjusted life year	Impact	
	Prevalence of stunting among children under age 5	Impact	*f*
	Mortality rate of children under age 5	Impact	
	Access to safe drinking water	Impact	
	Access to basic sanitation	Impact	

Topic	*Indicator*	*Category*	*Note*
Food, agriculture and rural livelihoods	Percentage of undernourished people	State	
	Percentage of poor people living in rural areas	State	
	Agriculture GDP as share of total GDP	State	
	Irrigated land as a percentage of cultivated land	Pressure, state	
	Agriculture water withdrawals as share of total water withdrawals	Pressure	
	Extent of land salinized by irrigation	State	
	Groundwater use as share of total irrigation	Pressure, state	
Industry and energy	Trends in industrial water use	Pressure	
	Water use by major sector	State	
	Organic pollution emissions (biochemical oxygen demand) by industrial sector	Impact	
	Industrial water productivity	Response	
	Trends in ISO 14001 certification	Response	
	Electricity generation by energy source	State	
	Total primary energy supply by source	State	
	Carbon intensity of electricity generation	Impact	
	Volume of desalinated water produced	Response	
	Access to electricity and water for domestic use	Pressure	
	Capability for hydropower generation	State	
Risk assessment	Disaster Risk Index	State	
	Risk and policy assessment indicator	Response	
	Climate Vulnerability Index	State	
Valuing and charging for the resource	Water sector share in total public spending	Response	
	Ratio of actual to desired level of public investment in drinking water supply	Response	
	Ratio of actual to desired level of public investment in basic sanitation	Response	*g*
	Rate of cost recovery	Driving force, response	*h*
	Water charges as percentage of household income	Driving force, response	*i*
Knowledge base and capacity	Knowledge Index	State	

Notes:

a: Several management-related topics have been omitted in this extract: Governance; settlements; valuing and charging for the resource; knowledge base and capacity

b: The categories are based on the so-called DPSIR (driving forces, pressures, state, impact, response) framework

c: Agricultural water use is covered under another topic

d: Now called '*dependency ratio'*

e: Now called *'Millennium Development Goal water indicator'*

f: Stunting = retarded growth

g: Proposed for United Nations World Water Development Report 3

h: Now called *'rate of operation and maintenance cost recovery for water supply and sanitation'*

i: Now called *'water and sanitation charges as percentage of various household income groups'*

Appendix B: Basin-level state indicators

Basin-level state indicators describe the basin as it is. They can be used for identification of development opportunities and conservation needs, as well as for monitoring of progress over time. Examples of indicators include, as relevant from case to case:

Social indicators

- Population density
- Access to safe water, sanitation and electricity
- Child mortality and malnutrition
- Employment, income, poverty
- Land ownership
- Size of land holdings
- Exposure and vulnerability to natural calamities (coastal floods, inland floods, landslides, drought) (as well as other calamities with different causes but related contingency and mitigation requirements, such as pests, cyclones, earthquakes, and tsunamis)

Infrastructure

- Irrigation infrastructure (coverage, operation and maintenance)
- Storage capacity
- Transport infrastructure (roads and waterways) (coverage, connectivity, operation and maintenance)

Resources

- Surface water availability (average and reliable)
- Groundwater availability
- Land availability (for cultivation, other livelihoods, and other developments)
- Hydropower potential and utilization
- Fish resources (actual and potential)
- Forest resources
- Aquatic habitats (including flood plains)
- Aquatic ecosystems and biodiversity
- Other water-related assets: Wetlands, lakes, waterfalls, scenic views
- Water quality (hygienic, chemical, saline intrusion)

Risks

- Morphological stability: Erosion, siltation, river planform
- Flood risk
- Drought risk
- Risk of spills
- Risk preparedness and contingency planning (floods, drought, pollution events)

Production systems and waste generation

- Efficiency of water-dependent production systems (economic efficiency and water efficiency)
- Use of agrochemicals
- Sewage production, treatment and disposal (domestic and industrial)
- Solid waste production and disposal (domestic and industrial)

Access to services

- Health services
- Monitoring mechanisms and access to information
- Agricultural and other livelihood-related extension services

Appendix C: Sources of data and information

The following sources of data and information can be accessed via the Internet:

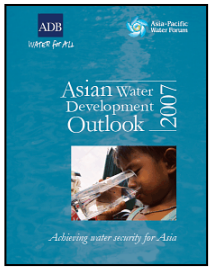
ADB key indicators 2009

http://www.adb.org/Documents/Books/Key_Indicators/2009/Country.asp

Country tables are available from the ADB website with 19 years of data about for example population; price indexes; labour force; production; external trade; and energy.

Asian Water Development Outlook 2007

www.adb.org/Water/Knowledge-Center/AWDO/



A valuable source of information (rather than data); assessments of development needs and policy implications; and introducing the Index of Drinking Water Adequacy (IDWA).

CIA World Factbook

https://www.cia.gov/library/publications/the-world-factbook/

Country maps and comprehensive, well updated country descriptions, covering

- Geography
- People
- Government
- Economy
- Communications
- Transportation
- Military
- Transnational issues

FAO Aquastat

http://www.fao.org/nr/water/aquastat/main/index.stm

'AQUASTAT is FAO's global information system on water and agriculture developed by the Land and Water Division. It collects, analyses and disseminates data and information by country and by region. Its aim is to provide users interested in global, regional and national analyses with comprehensive information related to water resources and agricultural water management across the world, with emphasis on countries in Africa, Asia, Latin America and the Caribbean'.

The online information system consists of:

- Databases:
  - (i) Main country database, with data on over 70 variables, searchable by country or by region per 5-year period;
  - (ii) African dams: Geo-referenced database with information about some 1300 dams in the 53 countries of the African continent;
  - (iii) institutions, covering around 650 institutions, searchable by country, by type of institution, by main activity, or by keyword;
  - (iv) river sediment yields for rivers and reservoirs around the world, searchable by river, by country and by continent; and
  - (v) investments in irrigation, covering 248 irrigation projects around the world.
- Countries and regions - Standardized text by country and by region on the state of water resources and agricultural water use
- Climate information tool: A tool to provide climate estimates for the land surface of the globe
- Water resources: Review of the statistics of renewable water resources by country
- Agricultural water use: Review of agricultural water use by country
- Global map of areas equipped for irrigation
- Maps and tables: A selection of maps and datasets on water and agriculture
- FAO publications and links to other websites related to water and agriculture

Human Development Reports (UNDP)

http://hdr.undp.org/en/

'Almost two decades ago, the first Human Development Report sent a clear message that human development is about enlarging people's choices, allowing them to develop their full potential and lead productive, creative lives in dignity and in accordance with their needs and interests. By ranking countries in a way which is more consistent with this thinking, the HDR report has helped shift the debate away from gross domestic product (GDP) per capita as the only measure of development. Instead, the HDI started providing a summary of each country's achievement in attaining:

- *A long and healthy life*
- *Access to knowledge*
- *A decent standard of living*

Since 1990, The Human Development Report has provided analysis, set the agenda and shifted the course and implementation on development policies worldwide'.

The related websites includes data tables in spreadsheet format; as well as analyses and maps, covering 179 countries/territories.

Note the particular water-related relevance of the 2006 volume: *'Beyond scarcity: Power, poverty and the global water crisis'.*

Themes of the Human Development Reports

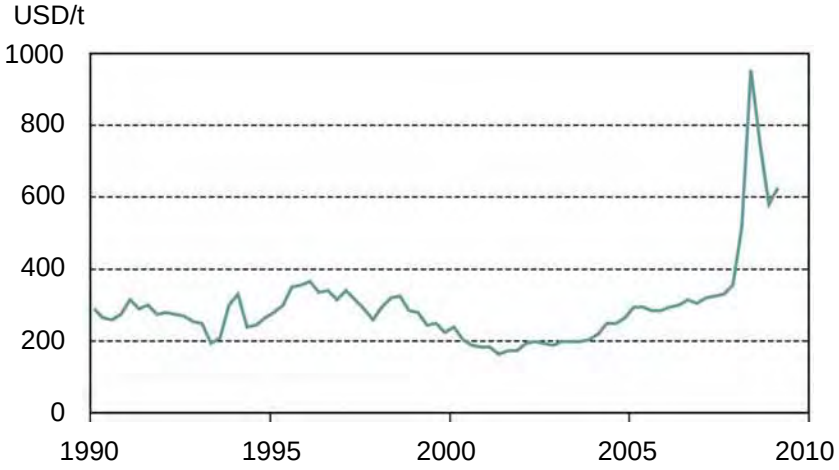
2009:	Overcoming barriers: Human mobility and development (in preparation, Oct 09)
2007/08:	Fighting climate change: Human solidarity in a divided world
2006	Beyond scarcity: Power, poverty and the global water crisis
2005	International cooperation at a crossroads: Aid, trade and security in an unequal world
2004	Cultural liberty in today's diverse world
2003	Millennium Development Goals: A compact among nations to end human poverty
2002	Deepening democracy in a fragmented world
2001	Making new technologies work for human development
2000	Human rights and human development
1999	Globalization with a human face
1998	Consumption for human development
1997	Human development to eradicate poverty
1996	Economic growth and human development
1995	Gender and human development
1994	New dimensions of human security
1993	People's participation
1992	Global dimensions of human development
1991	Financing human development
1990	Concept and measurement of human development

IMF commodity price index

http://www.imf.org/external/np/res/commod/index.asp

Data are available from the IMF website about 8 price indices and world market prices for 49 commodities, on a monthly basis since January 1980. The data coverage is good.

Figure E.1: The price of rice (IMF data)



IWRM guidelines at river basin level (2009)

http://www.unesco.org/water/news/newsletter/214.shtml#news_4

Prepared by UNESCO, its International Hydrological Programme, the UN World Water Assessment Programme and NARBO, with comprehensive support from Japan Water Agency, these comprehensive guidelines come in four volumes:

1 Principles

2.1 Guidelines for IWRM coordination

2.2 Guidelines for flood management

2.3 Invitation to IWRM for irrigation practitioners

The guidelines highlight various *'keys to success'.* Volume 2.1 includes case studies of river basins in Argentina, Australia, Indonesia, Japan, Philippines, Turkey, USA, and 6 states in the Volta Basin

Satellite-based weather data

Impressive data sets can be readily downloaded from the Internet:

- Rainfall data, so-called Multi-satellite Precipitation Analysis (TMPA) data, based on TRMM and other satellites, are available from the NASA website with a 0.25° by 0.25° resolution and a 3 hrs time increment in near-real time: http://lake.nascom.nasa.gov/Giovanni/tovas/realtime.3B42RT.2.shtml#description

  Due to the high resolution, these data can add substantial value to traditional long-term records, for example by describing high rainfalls on mountain slopes.

- Elevation (DEM) data are available for the whole World with a 90 m grid resolution from the NASA SRTM (Shuttle Radar Topography Mission).
- Cyclone/typhoon tracks and data are available from various regional warning centres, in near-real time and as historical records.

... and expectedly much more!

World Development Indicators (the World Bank)

http://go.worldbank.org/RVW6YTLQH0

This database lists 54 indicators over the period from 1960 to 2008 for 227 countries/territories (but with visible gaps in the records).

The indicators include

- Percent of population with access to improved water sources; and
- Percent of urban population with access to improved sanitation facilities

The World Water Development Report

http://www.unesco.org/water/wwap/wwdr/

Three volumes have been published under the World Water Assessment Programme:

2009: Water in a changing world

2006: Water: A shared responsibility

2003: Water for people, water for life

'The United Nations World Water Development Report, released every three years in conjunction with the World Water Forum, is the UN's flagship report on water. It is a comprehensive review that gives an overall picture of the state of the world's freshwater resources and aims to provide decision-makers with the tools to implement sustainable use of our water.

Through a series of assessments, the Reports provide a mechanism for monitoring changes in the resource and its management and tracking progress towards achieving targets, particularly those of the Millennium Development Goals (MDGs) and the World Summit on Sustainable Development. The Reports also offer best practices as well as in-depth theoretical analyses to help stimulate ideas and actions for better stewardship in the water sector.'

A large number of water-related indicators are applied in one way or another (but are not tabulated, neither in the publication itself nor on its website). (Many of them are available from other websites, however).

Workshop presentations, country papers, IWRM implementation

Much information - including recent information - about river basins and IWRM implementation is produced for presentation at conferences and workshops.

The NARBO website has a collection of links to is member organisations, including many Asian RBCs/RBOs: http://www.narbo.jp/narbo/links/index.htm

Center for River Basin Organizations and Management,
Solo, Central Java, Indonesia
www.crbom.org, info@crbom.org