Scientific and Technical Advisory Panel

The Scientific and Technical Advisory Panel, administered by UNEP, advises the Global Environment Facility

Report of the STAP and GEF Secretariat International Waters Indicator Review Workshop, 3-4 December 2008, Paris

1. The Workshop was held on 3-4 December 2008, hosted by UNESCO, 1 rue Miollis, Paris, France

2. The co-Chairs were Meryl Williams, Panel Member, Scientific and Technical Advisory Panel (STAP), and Alfred Duda, Senior Advisor, International Waters, GEF Secretariat. The co-Chairs were supported by staff from the STAP Secretariat and the GEF Secretariat and by UNESCO-IHP's local organizing team.

3. In addition to STAP and the GEF Secretariat, the Workshop was attended by representatives of the World Bank, UNDP, UNEP, UNIDO, FAO, Ramsar Convention on Wetlands, Stockholm International Water Institute, UNESCO IHP Secretariat, UNESCO-IHP, UNESCO-IOC and UNESCO World Water Assessment Programme.

4. Approach Papers and presentations to the Workshop were provided by three working groups, led by Jaroslav Vrba (Transboundary Aquifers System), Charles Vörösmarty (Surface Water) and Kenneth Sherman (Large Marine Ecosystems). The full list of participants is attached as **Annex 1**.

Day 1. 3rd December 2008

Session 1. Introduction

5. Alice Aureli opened the Workshop and welcomed participants on behalf of UNESCO-IHP. The co-Chairs informed participants that both STAP and the GEF Secretariat were collaborating to examine the use of globally representative datasets and derived indicators that might be utilized to express potential global benefits for GEF investment actions in International Waters. The co-Chairs informed participants that STAP and the GEF Secretariat collaborated to commission experts to provide Approach Papers to review the situation for transboundary surface water basins, transboundary groundwater systems and Large Marine Ecosystems (LMEs), and that the Workshop would act as a review body.

6. Peter Bjornsen (GEF Secretariat) made a presentation on findings of the Mid-Term Review of the Resource Allocation Framework and reported on the GEF Council's decision at its November 2008 meeting that requested the GEF Secretariat, in collaboration with the GEF agencies and STAP and other stakeholders, to present steps to improve RAF design and indices for the climate change and biodiversity focal areas for GEF-5, and furthermore to present scenarios for possible expansion of the RAF, if feasible, to all focal areas for GEF-5 for consideration by the Council at the June 2009 GEF Council meeting.

7. The GEF Secretariat informed the participants that the present Workshop would concentrate on the first steps of scenario development by reviewing the Approach Papers and by advising on the next steps to utilize available datasets and candidate indicators to contribute to a possible International Waters component of the RAF.

8. Matters arising from the briefings on the RAF were discussed. A participant questioned the RAF's country focus at the expense of an ecosystem based approach and another referred to NGO concerns that the RAF had concentrated resources in government at the expense of the more accessible Small Grant Program. The GEF Secretariat responded that the RAF policy does not state that it must be country-based, so it could be a water body based approach. The Council supports direct allocations to government under the RAF therefore the role of non-government bodies may indeed be weakened.

Session 2. Approach paper presentations

9. The Transboundary Aquifers System (Groundwater) Working Group made four presentations which sequentially dealt with defining characteristics (values) of aquifers, available datasets and indicators, analytical approaches and pilot testing using the three proposed indices, which are Trans-Boundary Aquifers (TBA) Intrinsic Value and Functions (I_{IV}), Human and environmental dependency on TBAs (I_{HE}), TBAs Vulnerability to stress (I_{RS}).

10. The Working Group also highlighted challenges that need to be addressed including the prioritization of transboundary aquifers; that surface water/groundwater linkages are not well understood; need for better management of climate change buffering role; data still generally poor.

11. Workshop participants welcomed the work done especially the pilot testing of the proposed indices that was presented in the form of four country case studies, and discussed the approach and the challenges. Participants noted that the presentations made were in general more structured than the submitted papers. FAO suggested use of the partial global coverage AQUASTAT (Global Map of Irrigation Areas) and globally complete LADA (Land Degradation Assessment in Drylands) datasets to improve data quality and coverage.

12. Ramsar advised caution when assuming a groundwater dependency relationship of Ramsar Sites based on the Ramsar Sites Database entries, but welcomed the interest, especially regarding recharge relationships between wetlands and groundwater. It was agreed to establish close cooperation between UNESCO's IHP and the Ramsar Convention Secretariat in order to plan possible studies and assessments of groundwater-dependant wetlands. UNESCO informed the workshop that the Spanish Geological Survey has conducted a study on groundwater-dependant wetlands in Spain that could be used as an example.

13. In response to a question from UNEP, the Working Group confirmed that possible social-economic indicators are not included in the general part of the report. However, they are formulated in Annex 2 of the report and applied in case studies focused on Sahara / Sahel TBAs and Mediterranean coastal aquifers. Proposed groundwater indicators under the Sub-Index 2 Human and environmentally dependency are also social based indicators. In response to a participants concern about potential confidentiality of social use data, FAO stated that water use data is publicly available for most countries and is unlikely to be concealed.

14. The Large Marine Ecosystems Working Group presented its Approach Paper, which argued for an ecosystems approach to management and a watershed perspective regarding runoff and pollution control and vulnerability modeling. Temperature anomalies and fisheries impacts were highlighted.

15. In subsequent discussion a number of suggestions for improvement were offered. The GEF Secretariat asked for the LME Approach Paper to also cover data and indicators relevant to enable assessment of the status and risk/threats to mangroves, sea grasses and coral reef components of the marine ecosystem. The World Bank was concerned about 'granularity' of data, i.e. loss of resolution at LME scale for e.g. hypoxia due to nutrient loading. It was noted that this concern can be addressed by using the publicly available sea surface temperature (SST) data at a much finer scale, down to 1 km, globally. The spatial gradients of SST (temperature fronts) also can be made available globally at a much finer, sub-LME scale. The Ramsar Convention noted the importance of the spatial and functional relationships between coastal wetlands and fisheries, and requested that data and indicators should also allow this aspect to be considered.

16. In response the Working Group agreed to consider the suggestions and committed to the studying and quantification of land side inputs to LMEs and inputs from the open ocean side into LMEs.

17. The Working Group for Surface Waters next presented its Approach Paper, reviewing the wide range of datasets and available indicators and making the case for an accounting tool that draws on clusters of datasets organized into four catchment scale categories: Water resources, pollution, disturbance and biological factors. The Group proposed creation of 'national water accounts' of supply or impairment regarding water services, and e.g. EPI "environmental performance index" could be used to do this regionally and by country to present the surface water status of a country. The Group also proposed creating GBI-relevant outputs, at up to 8km resolution and proposed time sequence benchmarked to

2000.

18. In response the GEF Secretariat proposed that the Group also look at trans-national scale to enable river basin comparisons (e.g. Nile, Mekong, Amazon) at global level and had concerns that the currently listed suite of data and indicators would be too complex for GEF to administer within a RAF. The Ramsar Convention noted that the suite of indicators focused at basin level, so there is little to focus on at global level, in order to be able to compare basins. GEF may be interested in using data to support global needs. Building on the long list of data and indicators even as currently grouped it is not clear how this maps back to the global environmental benefits. FAO advised that the FAO/University of Frankfurt Global Map of Irrigation Areas and related AQUASTAT data could have been used also.

19. The Working Group responded that dialogue is needed to make choices and to apply the appropriate data and indicators, and the Group is willing to adjust their proposals to GEF's needs if more clearly expressed.

Session 3. Breakout Groups discussion

20. Co-Chair Meryl Williams asked the three breakout groups to consider four issues:
    - Has the Working Group authoring the Approach Paper satisfied the ToR? (including identifying gaps)
    - Comment on choice of datasets
    - Recommended indicators relevance, gaps
    - Quality of analysis supporting choice

Report of the Groundwater Breakout Group (Chair Alfred Duda, Rapporteur Doug Taylor)

21. Participants agreed that the Terms of Reference for the Approach Papers could have been sharper, however overall the work done by the Working Group was considered very useful and well presented. Key improvements needed to fulfill the ToR include improved analysis, presently a specific transboundary focus is lacking, which is required to address future equity issues in allocation of resources, and a need to address the gap in status indicators. Ecosystem dependency on groundwater and the climate change adaptation significance of groundwater are gaps that need more analysis. The targeting of actions or identification of 'hotspots' was also recommended. The GEF Secretariat requested inclusion of data to illustrate Small Island Developing States (SIDS) examples, and also to relate groundwater to wetlands where possible. Finally a non-color groundwater resources map to enable cheaper reproduction would be helpful.

22. The Working Group responded that they would refine their approach and close key gaps, explaining that the approach to the presentation of social-economic indicators (indicators - Sub-indexes - GEF Benefit Index) will be the same as in the case of groundwater indicators (Figure 2 of the report) and legal indicators (Annex 3 of the report). On the maps depicting transboundary aquifers recharge and other vulnerable areas, discharge areas and groundwater flow system will be identified to show the shared groundwater system between neighboring countries. The Working Group was largely satisfied with their adherence to the ToR and the Breakout Group agreed with this view.

23. On choice of datasets, participants advised that dynamic land use changes may impact on groundwater, and also to be cautious in making assumptions about co-mapping of Ramsar Sites that imply groundwater dependence. The GEF Secretariat appreciated the four country case studies presented and asked for data examples for two forms of SIDS to be included and for consultation to take place with the Ramsar Convention. The Working Group agreed to the requests.

24. For expanding the choice of datasets and improving indicator coverage, FAO recommended using available land use and land cover global datasets conjunctively with groundwater data and World Bank further advised to use that with maps and data on recharge areas (from IGRAC) to delineate the changes (reductions in) recharge areas and recharge rates. World Bank also advised that change of land use related to a vulnerability index needs alternative ways of capturing, e.g. LADA data. The Ramsar Convention warned that protected area status is not an indicator for ecological needs, and if protected areas are mapped against groundwater one should not assume that water resources are also protected. The World Bank advised that the an indicator for reflecting increased stress on an aquifer

(due to reduced recharge area or recharge rate) from changes in land use and land cover should be included. Reduced recharge (rate and quantity) can result from reduced recharge area due to changes in land use from urban development, road construction, agricultural expansion, conversion of forested land on recharge areas. This omission, however, is a limitation of the ToR. Another gap was the absence of an indicator linking groundwater to groundwater dependent ecosystems. The Working Group accepted the advice provided on indicators.

25. The quality of analysis was considered good but the World Bank asked for it to be sharpened with reference to the end-goal. UNESCO asked for a framework and recommendation from the GEF to enable the Working Group to expend more effort. FAO asked for total economic value appraisal to be included. Questions were raised by the Working Group on whether to include aquifer-scale socio-economic analysis, including benefit sharing and related legal issues. It was decided that the legal and institutional indicators already included in the report, will be considered at a later stage as a performance index. The GEF Secretariat will provide further guidance.

Report of the LME Breakout Group (Chair Meryl Williams, Rapporteur Peter Bjornsen)

26. The Breakout Group focused its discussions on extracting a limited set of indicators that could be used in a possible IW Resource Allocation Framework from the very diverse information presented in the LME Approach Paper for the Workshop. Inspired by the modular approach for the LME TDA approach, the following seven categories of indicators were identified: 1) Productivity, 2) Ocean variability – impacts of climate change, 3) Fisheries and overexploitation of fish stocks, 4) Pollution with emphasis on land-based nutrient runoff leading to anoxia, 5) Critical habitats (coral reefs, mangroves, seagrass, coastal wetlands), 6) Valuation of goods and services (emphasizing food provision and tourism), and 7) LME Governance (e.g. TDA, SAP, Commission, Convention).

27. Fisheries was the category that proved most difficult to condense into a few indicators. Several indicators were suggested including biomass yield, commercial value of fisheries (note potential overlap with item 6) above), ecological footprint, trophic index of fishery harvest (as an indicator of the overfishing characteristic of 'fishing down the food chain'), catch by stock status (developing, fully exploited, over-exploited versus collapsed), and carrying capacity. The potential problem of under-reporting of fish catches was discussed.

28. The issue of spatial resolution of the indicators raised in the preceding plenary session was discussed. The authors of the Approach Paper stated that most, if not all, of the indicators presented could be calculated by country, at a cost, but that this would go against the LME philosophy. It was proposed that a potential IW/Marine RAF index could be composed of some indicators that would be shared among countries bordering a given LME and other indicators that could be calculated by country.

29. Accessibility and regular future updating of data were emphasized. The members of the LME Working Group referred to the comprehensive data set published as UNEP Regional Seas Report # 182. The Group was requested to provide web links to actual data points, similar to the metadata compendium presented by the Surface Water Group as Appendix 4 to their Approach Paper for the Workshop.

Surface Waters Breakout Group (Chair Ivan Zavadsky, Rapporteur Christian Severin)

30. The Breakout Group started out with a round of clarifying questions on the IW Global Environmental Benefit Indicators, not only in relation to the TOR but also in general. There was a lively discussion on TOR given and how it was to be understood. Especially on the issue of including the institutional issues along with the bio/physical GBIs. It was suggested to consult Aaron Wolf's data sets and maybe reflect upon it in the work performed by the Working Group.

31. The group went through the list of major themes and subsidiary driver data sets presented in the Surface Waters paper (Table 2A) after an introduction was given by the author: The large number of driver data sets has been divided into four main themes. In short, the datasets has been well chosen. The Working Group was requested to work through the indicators listed with the main goal of trying to boil down the large number of driver sets down to 4 indicators. In this process it was identified that some of the driver sets were overlapping with focal areas such as POPs and Biodiversity.

32. In the process of recommending indicators relevance/gaps the Working Group specifically identified the need for keeping the end-users in the dialogue, in order to form the correct indicators (capacity, governance, environmental status). According to the author of the Surface Waters Paper, the process of identifying the relevant main questions to be asked (Avoiding conflicts, Provide sufficient water for environmental flow to sustain coastal wetlands, Limiting nutrient loading etc.) to be able to guide what driver sets have most relevance, may need the involvement of a formal advisory committee.

33. However, during the group session on Day two, the group succeeded in identifying, out of the 23 original driver sets, a reduced set of drivers: Fragmentation of river habitat, Water consumption, BOD, Nitrogen loading, Agriculture, Wetlands disconnectivity, High Aquatic endemic species diversity, Wetlands and water-related sites/ecosystems of international importance (Ramsar and World Heritage Sites) within the four categories (1) Water Resource Development and water Service, (2) Pollution of water supply and inland waterways, (3) Watershed Disturbance & (4) Biology.

34. With the driver datasets developed the group agreed that it will be possible to get one composite/aggregated number for each freshwater basin, using the four main themes and their associated drivers. It was finally suggested to test the driver sets and the methodology on a number of different freshwater bodies (2-3) to understand what kind of classification the methodology would deliver. It was agreed to test it on Surface Waters bodies representing different ecological systems.

Session 4. Plenary discussion

35. Rapporteurs for each session provided verbal reports to the plenary on the findings of each breakout group. Participants considered how to guide the Working Groups to provide more focus, including how to refine the lists of indicators, select aggregated indices, and sets of questions to enable this focus. It was agreed that practical demonstrations are needed to focus on relevant indicators. In the context of thematic and data overlaps the World Bank asked where transboundary basins stop at the coast and recommended prioritizing stress reduction and environmental status indicators, with adequate monitoring to set a baseline.

Day 2. 4th December

Plenary discussion, continued

36. Alfred Duda, co-Chair, provided an introduction to seek feedback from each of the three Working Groups on what they understood about needs to be further addressed in their Approach Papers, e.g. hypoxia, reefs, mangroves, corals to add to LMEs, biodiversity of freshwater basins e.g. fish, water stress indicators.

37. The GEF Secretariat [Peter Bjornsen] presented the experiences and informed about the likely further development in implementing the RAF, with indications of the possible scope, including for inclusion of transboundary governance and socio-economic indicators under the RAF GBI and GPI indexes respectively. The World Bank [Tracy Heart] emphasized the opportunity and the importance to build transboundary governance indicators in the GBI for the IW FA, and to standardize an economic approach as an intermediate layer and offered to coordinate with the groundwater group.

38. As a cross-cutting issue, the World Bank advised that management actions in freshwater basins and LMEs are both involved to reduce hypoxia, however the LME Working Group consider that hypoxia can be treated locally within the LME

39. <u>Surface water discussion</u>. The Working Group proposed that two main needs-related areas should be considered (a) Human availability of water (food security, drinking) and (b) Water for ecosystems. However, the Group was unclear whether GEF is seeking conservation of ecosystems while also seeking to provide water services for human use and activities, and should a GBI also include governance related impacts? Other questions raised by participants included whether GEF will promote a country or basin approach for RAF and whether there will be three transboundary frameworks or just one.

40. The GEF Secretariat advised that while the rules were not set, data and indicators should support both country and basin approaches, but that a waterbody approach is preferable to emphasize the functional

unit rather than a country boundary focus for indicators and indices. While socio-economic indicators will be included in the GPI the transboundary governance indicators may not be. The World Bank and the Ramsar Convention recommended that transboundary governance indicators specific to water and natural resources management need to be included in the GBI if not included in the GPI, using experience from the expert GPI community. The justification would be the need to take into account governance-related indicators of particular relevance to water management in transboundary basins, e.g., conflicts over water arising from weak water governance in individual countries within a transboundary basin. In this context issues of over-extraction, abstraction, water quality, land use and land cover changes should also be addressed, all set against a background of high species endemism, migratory species interest etc., and also tested against human use.

41. Groundwater discussion. Actions to take forward include:
    - Already included case studies of aquifers in America, Africa and will now add two SIDS studies.
    - Add ecosystem view and work with Ramsar.
    - Using WHYMAP make grayscale version of the map for distribution (A4 size).
    - Although quality information is restricted compared to the quantity and use indicator (related to groundwater), aim to correlate groundwater with surface water and collaborate with Ramsar and the surface water group.

42. Large Marine Ecosystems discussion. The Working Group noted that an ecosystem approach calls for socio-economic treatment. Service functions, such as those impaired by eutrophication, are undervalued in all 64 LMEs. Actions to take forward include:
    - Consider reprocessing data at a sub-LME scale for e.g. country level for nutrient over-enrichment.
    - Simplify and include fish and fisheries enhanced data.
    - Seek data (and indicators) on seagrass, corals and mangroves.
    - Include the open ocean systems, currently not within LMEs, and especially the Pacific Ocean warm water pool that supports the biggest tuna fisheries.

Session 5. Selection of data and indicators to take forward

43. Meryl Williams, co-Chair, asked each Group to break out and consider their proposed data and indicators against the following criteria, provided by the GEF Secretariat:
    - Relevance to the GEF in the long term (global benefits)
    - Global availability on an annual basis (update)
    - Equity
    - Reliability

44. The co-Chair informed the workshop that STAP will commission follow-up reviews of the choices made and the results of the selection of data and indicators to take forward which were discussed in the three breakout discussions are attached as **Annex 2**, which includes tables for each of the three thematic areas of the International Waters focal area.

Session 6. Cross-cutting issues

45. The plenary session on cross-cutting issues considered overlaps and gaps that the three Approach Papers had left unresolved, and the discussion centered on agreeing specific actions to be taken by each Working Group as follow-up to their initial papers. Alfred Duda, co-Chair, asked each group to share data with each other, e.g. incursion, nutrient seepage, over the next nine months to enable gap filling and to reduce duplication of effort, and also drew attention to sources of new data via UNEP's new global projects on science and the Transboundary Waters Assessment Programme (TWAP). The discussion covered the following main issues: missing data and need for data exchanges; indicator overlap; valuation of goods and services.

    Missing data and exchange actions to take forward:
    - Coastal aquifers, especially shallow aquifers linked to rivers, should be considered by all three groups.

- Seasonal flows into rivers from groundwater and associated drought management should be included in the surface water and groundwater work.

Indicator harmonization:

- Compare draft indicator sets to eliminate overlap and consider loading common indicators with higher weight.
- Indicators that link changes in flow and e.g. sediment in large river basins to oceans
- Apply all three sets of indicators to SIDS.
- Food productivity indicator common to all three.

Valuation of goods and service:

- UNEP should provide valuation data for South China Sea and Guinea Current projects.
- Ecosystem valuation requires further work by a separate expert group.

46. Cross-cutting issues were also discussed by the group in the context of relevant indicators and **Annex 3** lists preliminary cross-cutting groupings and candidate indicators for further consideration.

Closing Session

The co-Chairs thanked the hosts UNESCO and the participants for making a successful workshop possible, followed by Mr Patricio Bernal, Assistant Director-General of UNESCO-IOC, who provided a closing statement.

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Annex 2. Selected indicators for further development

Note that the overview of Indicators are those chosen after selection in breakout groups (out of the original submitted listings). The consultants will be given the opportunity to test these further following the Workshop and a later version will be used to support potential indices

Groundwater

Sub-Index	Indicator	Classification		Source of data
1. Intrinsic Value and functions	• Mean annual rate of current groundwater recharge	1	Low < 20 mm/year	WHYMAP-Map of Groundwater Resources of the World, scale 1:25 M, WHYMAP- Map of Groundwater Resources of the World -Transboundary Aquifer Systems, scale 1:50 M, Les Eaux Souterraines dans le Monde, Global Overview in IGRAC's GGIS
		2	Medium 20 – 100 mm/year	
		3	High > 100 mm/year	
	• Potential storage capacity (inclusive of non-renewable and fossil aquifers)	1	Low (areas with local and shallow aquifers)	WHYMAP- scale 1:25 M, Les Eaux Souterraines dans le Monde, Global Overview in IGRAC's GGIS, UNESCO-ISARM regional studies of TBAs
		2	Medium (areas with complex hydrogeological . structures)	
		3	High (major groundwater basins)	
	• Natural vulnerability	1	Low (deep confined aquifers)	WHYMAP- scale 1:25 M, Les Eaux Souterraines dans le Monde, Global Overview in IGRAC's GGIS, UNESCO-ISARM regional studies of TBAs
		2	Moderate (confined aquifers and deep unconfined aquifers)	
		3	High (shallow, coastal, karstic aquifers, aquifer lens in small islands)	
	• Natural quality - based on Drinking Water Standards (DWS), or if data are not available on electric conductivity EC , chloride Cl, and pH DWS)	1	Low quality	WHYMAP- scale 1:25 M, Les Eaux Souterraines dans le Monde, Global Overview in IGRAC's GGIS, UNESCO-ISARM regional studies of TBAs
		2	good quality (fulfilling drinking water standards or EC, Cl, pH DWS)	
2. Human and environmental	• Dependency on groundwater for drinking water proxy (as percentage of total drinking	1	Low (< 20%)	Global Overview in IGRAC's GGIS, UNESCO-ISARM regional
		2	Medium (20-50%)	

dependency	water use)	3	High (> 50%)	studies studies of TBAs, FAO- Aquastat, National statistics
	• Dependency on groundwater for agriculture and other uses (as percentage of total water use)	1	Low (< 20%)	World Land Use Map, Global map of irrigation areas, Global Overview in IGRAC's GGIS, UNESCO-ISARM regional studies of TBAs, FAO-Aquastat, National statistics
		2	Medium (20-50%)	
		3	High (> 50%)	
	• Ecosystem dependency on groundwater	1	no dependency	WHYMAP- scale 1:25 M, list and map of Ramsar Sites in the World
		2	dependency	
3. Vulnerability to stresses	• Vulnerability to diffuse pollution (as percentage of total aquifer area)	1	low (spatial extent of intensive agricultural activities < 20%)	Les Eaux Souterraines dans le Monde , World Land Use Map, Global Overview in IGRAC's GGIS, FAO World Map on Intensive Agriculture Areas, UNESCO-ISARM regional studies of TBAs
		2	Moderate (spatial extent of intensive agricultural activities 20-50%)	
		3	High (spatial extent of intensive agricultural activities > 50%)	
	• Vulnerability to depletion (based on groundwater recharge and aquifer potential storage capacity, coupled with groundwater table measurements data (if available) and rate of water withdraw if known	1	Low (recharge > 100 mm/year, high gw. Storage, seasonal gw. table fluctuation)	WHYMAP- scale 1:25 M, Les Eaux Souterraines dans le Monde, Global Overview in IGRAC's GGIS, UNESCO-ISARM regional studies of TBAs
		2	Moderate (recharge < 100 mm/year, limited gw. storage)	
		3	High (recharge < 20 mm/year, low gw. Storage, long term gw. table decline)	
	• Climate variability and change	3	High (coastal and SIDS aquifers, shallow water table aquifers, aquifers in arid zones-recharge < 2 mm/year)	WHYMAP- scale 1:25 M, Les Eaux Souterraines dans le Monde, World Map of the Köppen-Geiger Climate Classification updated, UNESCO-ISARM regional studies of TBAs, G-WADI
		2	Moderate (aquifers in semi arid zone- recharge < 20 mm/year)	
		1	Low (other aquifers in different climate zones)	

Large Marine Ecosystems

Sub-Index	Indicator	Data Sets
Productivity	Primary Production	UNEP Report (Sherman et al., 2008) AMBIO paper (Sherman et al., 2008)
Climate Change impact	Climate Change impact / Oceanographic Variability	Time series of SST and delta SST; [Time series of SSS (near-future)]
Fisheries	Fish and Fisheries: Biomass yield trends	UBC/FAO data base on LME basis; by country
	Fisheries and Aquaculture values	Pauly et al. /UBC data base
	Ecological footprint	Christensen et al. (IOC Report #80)
	Trophic index trends	Pauly and Christensen
	Stock catch status	Pauly and Christensen
	Carrying capacity	Pauly and Christensen
	Fisheries: % GDP from LME-linked countries	
Pollution	Nutrient over-enrichment (normalized); area, impact, coastline	Seitzinger et al. (2008); by LME; by country; by watershed; total and anthropogenic
Operational complexity	GBI: # countries adjacent to the LME	
Vulnerable habitats	Habitats: Coral reefs Mangroves Seagrass Coastal wetlands	WCMC; GCRMN Ramsar
Valuation	National indicators; Input/output estimates from LME g&s	Costanza et al. (global estimates) By country estimates
GPI governance	Gov. Indicators: TDA, SAP, Commission & Convention	By LME (0/1)
Note:	Normalization: Consistent approach needed	

Surface Water Basins

Major theme	Driver data set	Variable or basin condition represented	Source	Data format	Availability
Water resource development and water delivery service	Fragmentation of Riverine Habitat due to Reservoirs	Global distribution, density, and number of dams, local in nature	GWSP-GRAND data set	Point and vector format	Requires resampling and linkage to digital data layers for stream networks (i.e. HydroSHEDS)
	Flow Distortion: Water Consumption	Depletion of flow	Using methods in Vörösmarty et al. 2005	0.1 x 0.1 degree global grid	No further processing required
Pollution of water supply and inland waterways	Nitrogen Loads	Nitrogen loads to the landscape including human, livestock, fertilizer, deposition and fixation for preindustrial and contemporary conditions	From Green et al. 2004	30X30 arc-second global grid	No further processing required
	Organic Loads (BOD)	Organic loads (BOD) calculated from sewered nitrogen loads and using a	Green, et al., 2004; Janssen et al, 2002 and Horan et al, 1994	30X30 arc-second global grid	No further processing required

		BOD:N ratio based on treatment level.			
Watershed disturbance	Agriculture Landuse Distribution	Mapping of active croplands including irrigated and rainfed croplands	Ramankutty, et. al., 2008; Thenkabail,et al, 2008 (GIAM)	5X5 and 10X10 arcminute global grids	No further processing required
	Wetlands and Wetland Disconnectivity	Percent of wetland occupied by cropland and impervious area	Lehner and Doll, 2004, Ramankutty, 2008, Elvidge et al., 2007	2X2 arc-minute global grid	No further processing required
Biological factors	High Aquatic Endemic Species Diversity				
	Water related sites of international importance (Ramsar and World Heritage)	Area of wetlands designated as international protected area	www.ramsar.org http://whc.unesco.org/		

Annex 3. Preliminary List of Cross-Cutting Issues to Possibly be Addressed by Indicators

Cross-Cutting Issues Driven by Factors External to the Water Systems	• Land use, land use change
	• Climate change o Ice melt rates o Drought effects on all water systems
	• Population growth
	• Economic drivers
	• Food production systems and their water uses
	• Valuation of water and aquatic resources, eg. Fisheries, biodiversity
	• LNP???
Cross-Cutting Issues Driven by Interactions Between the Water Systems	Surface Water-Ocean • Effects in ocean of discharges from river basins: nutrients, sediment, pollutants, total water drainage • Discharge effects on coastal landforms
	Ground Water-Ocean • Salinization of coastal freshwater aquifers • Contamination of shallow alluvial aquifers by nutrients, other pollutants
	Ground Water-Surface Water • Change in freshwater use practices • Recharge/replenishment rates for groundwater • Nutrient, other pollutant discharges from surface water to groundwater during replenishment
	SIDS-Ground Water-Surface Water • Water interfaces
Cross-Cutting Issues Between Water Systems, Biodiversity, Climate Change, Land Degradation and Chemicals Focal Areas	• Biodiversity: aquatic biodiversity needs to be given a better weight in the GEF RAF • Climate Change: need to recognize the multiple dimensions of climate change on water and water dependent resources. Beyond temperature change, factors such as drought, ocean current changes, salinity change and ocean acidification will all impact on aquatic ecosystems. • Chemicals: Globally, few data are available for chemicals in the environment. SAICAM is the appropriate convention to advise on chemicals indicators for water. • Land Degradation: Indicators of relevance to IW include land use/land use change, food production systems, etc