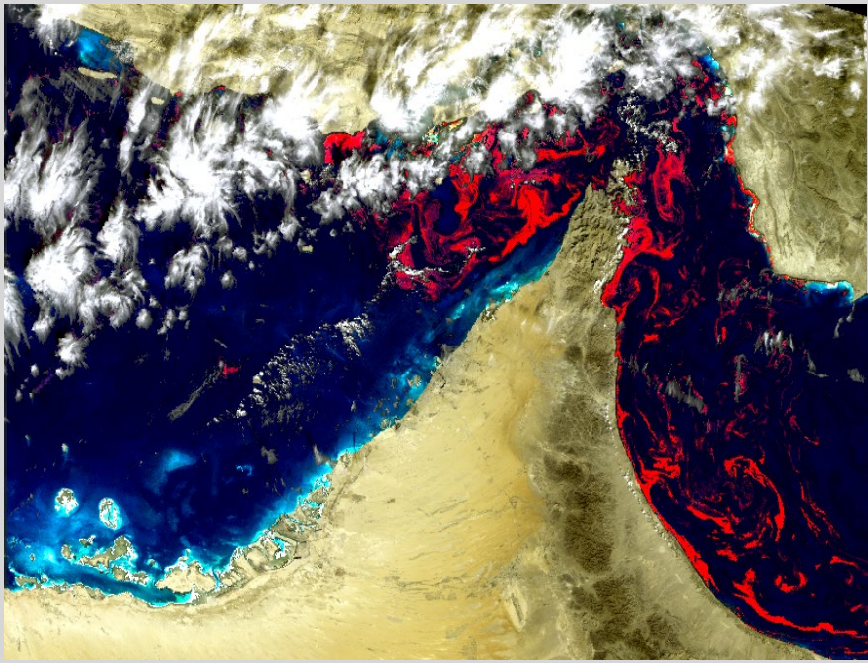
Task Team on HABs and Desalination



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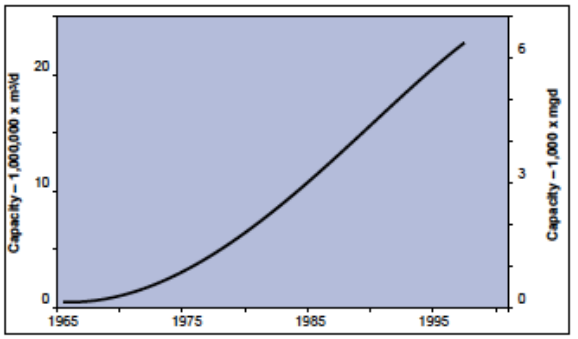
Desalination facts

- There are approximately 21,000 seawater desalination plants in operation worldwide, a significant increase from a decade ago, with the sector's capacity growing at 6-12% annually
- More than 300 million people around the world rely on desalinated water for some or all their daily needs
- The global urban population facing water scarcity is projected to potentially double from 930 million in 2016 to between 1.7 and 2.4 billion people, in 2050.



Total installed capacity of desalting facilities

Source — 1998 IDA Inventory

HAB issues for desalination

- Potential for HAB toxins to be retained in treated (fresh) water.
- HAB biomass and extracellular products can clog intake filters and compromise the performance of RO membranes
- HABs can cause taste and odor problems in treated water

'Red tide' forces desalination plant closure

by Andy Sambidge on Monday, 17 November 2008

The Sharjah Electricity and Water Authority (SEWA) has suspended the operation of the new water desalination plant in Khor Khan due to the red tide phenomenon off the coast of Khor Fakkan city.

WATER PLANT: SEWA has suspended operations at Khor Khan desalination plant after a build up of algae. (Getty Images - for illustrative purposes only)

SEWA added that it has resumed operation of some wells to provide sufficient water to the city until the problem is solved, indicating that it was monitoring the sea water at the water drainage line as well as checking samples of the sea water around the clock.

SEWA has called on consumers to ration water and take required precautionary measures, news agency WAM reported.

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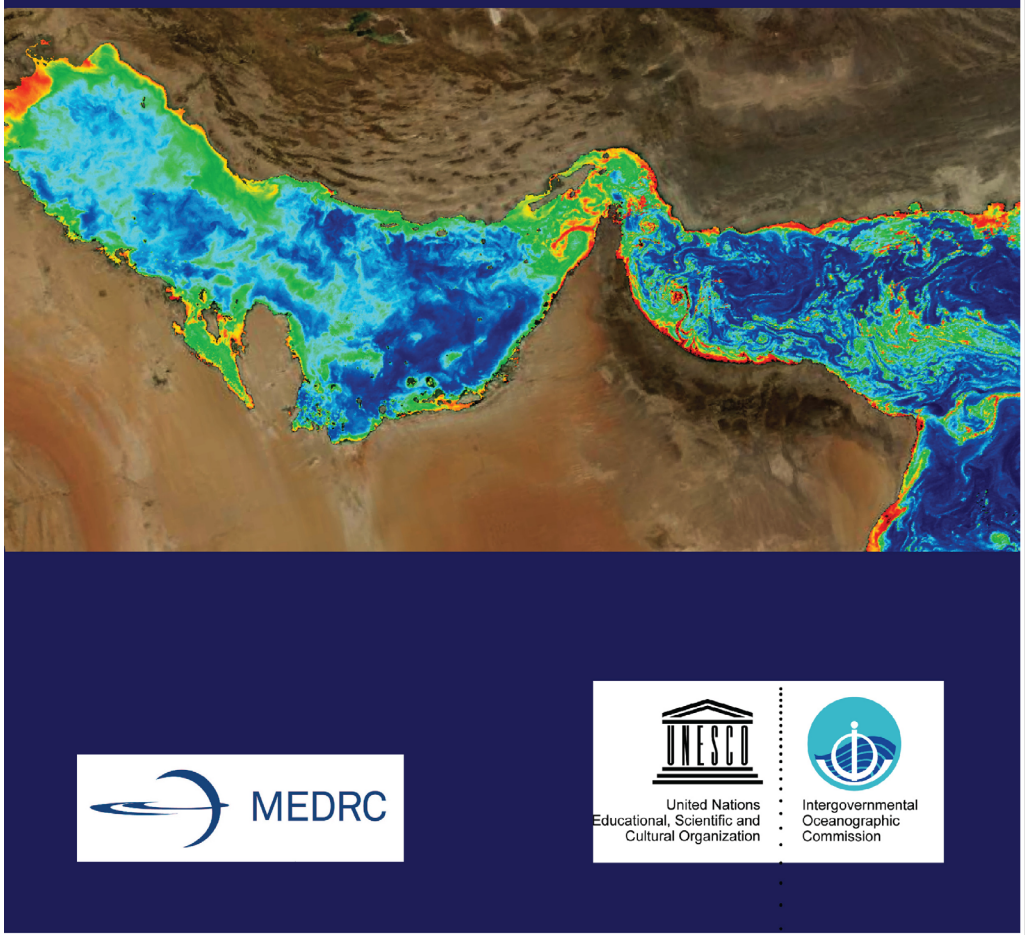
Past Task Team Activities

1. Task Team formed – IPHAB X (2011)
2. Organized and convened MEDRC HABs and Desalination workshop Feb. 2012 (Oman) (60 participants)
3. Organized and convened International Conference – Muscat, Oman, April 2014. (130 participants from 18 countries)
4. Published HABs and Desalination Manual (2017)



4. Published (2017) in the IOC's *Manuals and Guides* series

>600 pages

Intended to be a practical resource for the desalination industry

Many chapters written by desalination professionals (more than 60 chapter authors and co-authors)

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5. Considered convening a second international conference.

Polled desalination professionals – academic and industry

Quotes from desalination industry colleagues:

1. *"With the recent release of the book and the lack of new data, there has not been a strong interest in convening a second meeting at this time. We still lack data on the operation of certain pretreatment systems during a full HAB event (e.g., DAF). Perhaps in a few years it would be justified."*
2. *"A session at a conference (4-5 good oral presentations) is fine or a side event dedicated to HABs may also be an option."*
3. *"I'm chairing the IDA World Congress HAB session and there are few submissions".*

Terms of Reference

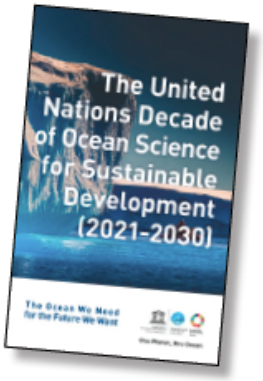
i. Assess and explore interest within the HAB and desalination communities for special HAB sessions or satellite workshops during regular international desalination conferences

- The TT Chair initiated discussions with Shannon McCarthy, Secretary General and Executive Director, International Desalination and Reuse Association to discuss increasing HAB community interactions with the desalination industry.
- A number of different approaches to increasing interactions between the HAB Community and the desalination industry were discussed with McCarthy and others in the desalination community.
  - Seeking an invitation to give a **plenary presentation** at one of the major desalination conferences
  - **Host a HAB session**. One possible venue for this type of activity is the IDRA Reykjavik Summit on Water and Climate Change in Iceland in October 2025.
    - Although there is some interest in pursuing this interaction, and discussions are ongoing at this time, concerns have been raised as well. One comment from the desalination industry was that *"Over the last 5 years there has been very little discussion on HABs during our sessions. As far as I've seen, there have been very few major HABs, if any. Between 2018 and 2024 I worked very closely with a number of plants in Chile, Middle East and Australia, where we have seen blooms before. In these locations I haven't heard of any recent HAB issues. So it seems interest in HAB impacts has waned."*
    - Anther comment was to consider *"… a broader session topic (e.g., preventing/detecting/predicting organic fouling and/or biological fouling) as a common theme to get more contributions. Topics related to HABs would fit well to this session."*

Fig. 1. The UN Division for Ocean Affairs and the Law of the Sea supports the implementation of UN Sustainable Development Goal 14 to conserve and sustainably use the oceans, seas and marine resources for sustainable development

Maggie Broadwater, NOAA, Charleston, South Carolina, USA

Don Anderson, WHOI, Woods Hole, Massachussets, USA



Harmful algal blooms were a key discussion topic at the 24th meeting of the United Nations Informal Consultative Process on Oceans and the Law of the Sea (*ICP-24*) in New York, 17-19 June 2024. The three-day event, led by the *UN Division for Ocean Affairs and the Law of the Sea* (Fig. 1) featured individual presentations and panel discussions with UN delegates addressing the ocean as a source of sustainable food. ICP-24 emphasized sustainable ocean foods as an area where coordination and cooperation at the intergovernmental and inter-agency levels should be enhanced, and recognized the impacts of harmful algal blooms (HABs) on the safety and security of sustainable ocean foods.

During this event, Philipp Hess (PHYTOX Director, *IFREMER*) discussed the biological and chemical diversity of HABs in a changing climate and related risks to food safety and security; Maggie Broadwater (*ECOHAB* Program Manager, NOAA/NCCOS) discussed the impacts of HABs on the environment, societies and economies; and Don Anderson (Senior Scientist, *WHOI*) shared technologies and approaches to HAB early warning, mitigation, and control, with a focus on NCCOS-funded research on *Alexandrium catenella* blooms in Alaska and control technologies for *Karenia brevis* in Florida (Fig. 2).

The *HAB Solutions Programme*, recently endorsed by the UN Decade of Ocean Science for Sustainable Development, was highlighted during the presentations. This program is led by the Intergovernmental Panel on HABs (*IPHAB*), and will augment existing international coordination efforts through the IPHAB, GlobalHAB and IOC Regional Working Groups, and bolster cooperative efforts to reduce the adverse

Fig. 2. Philipp Hess, Maggie Broadwater, and Don Anderson at the UN ICP-24 meeting. Philipp and Maggie currently serve as the Chair and Vice Chair, respectively, of the IOC Intergovernmental Panel on HABs (IPHAB), and are working to advance the IPHAB's HAB Solutions Programme

Another intercessional activity under this TOR was a presentation by the TT chair at the 24th meeting of the **United Nations Informal Consultative Process on Ocean's and the Law of the Sea (ICP-24)** in New York, 17-19 June, 2024. This event featured individual presentations and panel discussions with UN delegates. Anderson's presentation was on new technologies in HAB management, and included material on desalination plant impacts from HABs and possible mitigation strategies.

TOR (i)

Recommendations:

1. Continue discussions about inclusion of HABs in desalination association meetings.
2. Add new members from countries with significant desalination plant capacity and hold discussions during IPHAB XVII to explore other communication options with the desalination industry.

Terms of Reference

ii) ***Formulate a proposal for a joint FAO/WHO water safety risk assessment (or what available data allow) for toxins in drinking water coming from desalination plants, working closely with the appropriate FAO division, including on aspects of chronic, low-level toxicity.***

iii) In the context of HABs being detrimental to water security (either to public health or to freshwater production procedures), request cooperation with the FAO Land and Water Division for support to evaluate the increased needs for freshwater production through desalination for both secure drinking water and freshwater for agricultural use.

- Relatively little progress was made on these two closely related TORs for several reasons, suggesting that discussion is needed during IPHAB XVII to explore options for moving forward.

  – At the last IPHAB session, the TT noted that IOC Manuals and Guides, 78: *Harmful Algal Blooms (HABs) and Desalination: A Guide to Impacts, Monitoring and Management* was published in 2017, and that **this manual includes a chapter that covers water safety risk assessment in detail**, The relevant chapter is: Soltani, A., Hess, P., Dixon, M.B., Boerlage, S., Anderson, D.M., Newcombe, G., House, J., Ho, L., Baker, P., and Burch, M. *World Health Organization (WHO) and international guidelines for toxin control, harmful algal bloom (HAB) management, and response planning*. There has not been a request from the desalination industry for something newer and more official.

Table 8.3. Acute risk of poisoning from drinking desalinated water assuming 100% of the toxin in a major HAB is dissolved or extracellular.

Toxin	Theoretical safe dose [a] (µg)	MPL [c] (µg/L)	Extracellular toxin concentration, (µg/L) [d]	Safety factor, raw intake water [e]	Safety factor after 99% rejection [f]	Concentration to detect in drinking water [µg/L] [g]
Saxitoxin	30	15	600	0.025	2.5	0.15
Domoic acid	1,800	900	335	2.7	270	90
Okadaic acid (and DTXs)	18	9	577	0.016	16	0.9
Azaspiracid	12	6	0.1	60	6000	0.6
Microcystin [b]	2	1	1.4	0.7	71	0.1

[a] The theoretical safe dose is calculated based on the ARfD by EFSA (Summary Opinion, 2009); it refers to a 60kg person.

[b] Safe dose for microcystin separately derived from WHO guideline. Extracellular concentration estimated from Kudela 2011; Miller et al. 2010.

[c] MPL = Maximum permissible level; based on a consumption of a 2-L dose of desalinated water.

[d] Assumes that 100% of the total toxin from a dense bloom (5,000,000 cells/L) of the most toxic species producing each toxin is extracellular.

[e] The safety factor is the ratio of the MPL to the extracellular concentrations of each toxin. Safety factors greater than 1 indicate a safety margin. Safety factors below 1 indicate a higher risk.

[f] This assumes 99% rejection by the SWRO and thus considers only a single pass and no problems with the membranes.

[g] This concentration is arbitrarily set at 1/10th of the MPL or maximum permissible level

TORs ii and iii

Recommendations:

1. Seek input from the Panel during IPHAB XVII.

Note # 1: The TT representative from FAO points out that it has been difficult to find an individual in the FAO Water Department willing to support the concept of a risk assessment, noting that work on drinking water mostly comes from WHO.

Note #2: To trigger a formal risk assessment, FAO and WHO need to agree on conducting one and then make an international call for experts, have a drafting group, a physical meeting and then finalize the report.

Terms of Reference

TOR (iv)

In coordination with the IPHAB Task Team on Early Warning Systems for HABs, explore opportunities to work with the desalination industry and its academic partners to communicate and implement capabilities for HAB early warning systems through scientific presentations, workshops or other activities;

- Potential interactions between the two task teams has been discussed on multiple occasions. The TT believes that desalination plants are prime candidates for early warning systems, and this has been borne out by enthusiasm for the topic expressed at an EWS workshop in Namibia as well as at the IOC Assembly.

- Despite this enthusiasm, few specific activities can be reported at this time. An exception is a pilot project in the Baltic Sea where desalination plants are operated on some of the larger islands. A Swedish pilot project *Forecast framework for algae blooms to secure water supply on Gotland* is underway. Oceanographic modelling is combined with automated *in situ* observations, manual sampling, satellite remote sensing of ocean color and analyses of cyanotoxins to provide early detection and ultimately early warnings of toxin-producing cyanobacteria. During the project, no problems with cyanobacteria and the desalination plants have occurred.

TOR (iv):

Recommendation:

1. It is recommended that as activities for the EWS test team are discussed during IPHAB XVII, that efforts be made to develop concepts that could further this TOR. For example, if additional Pilot Projects or workshops are anticipated, it would be worthwhile to include a member of the HABs and Desalination Task Team to help deonstrate the value of automated HAB detection and monitoring instrumentation for desalination plants.

Terms of Reference

TOR (v): ***Engage with desalination plant operators, drinking water suppliers and authorities managing water supplies for agricultural uses on the potential impacts of HABs on the capacity for desalination to provide adequate freshwater supplies under a range of climate scenarios including increased periods of drought.***

- No progress was made on this TOR as it is unclear how to approach this request.

Terms of Reference

TOR (vi): When appropriate, provide newsworthy articles on HABs and desalination for publication in Harmful Algae News.

The task team is not aware of HAB events that have affected desalination plants in recent times, so no HAN articles have been suggested.

TOR (vii): Invites WHO and ROPME to nominate a representative to participate in the Task Team

No action needed.

Discussion:

1. Should the task team continue?
2. If so, what activities should be undertaken?
   - HAB and desalination community interactions
   - FAO and WHO risk assessment
   - Interactions with EWS task team
   - New Chair? Co- chairs?

Possible terms of reference (old)

1. *Continue to assess and explore the interest in the HAB and desalination communities for either:*
   a) *a follow-up second International Conference on HABs and Desalination, options for funding, for a host, and a venue ; or*
   b) *special HAB sessions or satellite workshops during regular international desalination conferences—in both cases, the objective would be to:*
      - *Review the state of knowledge on the impact of HABs on desalination plants and other facilities that utilize large volumes of seawater in commercial or industrial applications,*
      - *Discuss current thoughts and evidence concerning possible expansion or movement of*
      - *HABs due to climate change and other global change stressors*
      - *Highlight new ocean observing technologies as well as the engineering and operational strategies that are used, or could be used, to detect, forecast, and mitigate the impact of HABs and other planktonic threats to desalination facilities,*
2. *Explore opportunities to further develop and apply Early Warning Systems in areas reliant on desalination*
3. Investigate the interest of WHO and FAO to cooperate with the IOC on a risk assessment of marine toxins in drinking water from desalination plants.
4. *UN Decade involvement??*

Manuscript in preparation:

- Health risk of marine harmful algal bloom biotoxins on desalinated drinking water: a review

  Marie-Yasmine Dechraoui Bottein, Esther Garrido Gamarro, Donald M. Anderson, Philipp Hess, others?

- Establishing guidelines for desalination remains challenging given the absence of toxin data from desalinated drinking water and the limited study exploring toxin removal by desalination processes.
- This study proposes acute health-based values for marine biotoxins in desalinated drinking water derived from acute references doses (ARfDs) and using different fraction of exposure scenarios.
- Considering that the toxins associated to HABs are typically well removed by desalination processes, biotoxins are unlikely to represent a significant health risk under most circumstances. However the risk cannot be excluded when unusually dense bloom with high toxin concentration occur or if desalination systems are damaged.
- Adequate water safety plans should be developed involving intensive HAB and toxin monitoring and control points to monitor the integrity of the RO process and the quality of brine discharge, to protect consumers, ensure continued supply of drinking water and protect the environment.