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Summary of the Workshop
held on 28th June 2002 in Adelaide

Endocrine Disrupting Chemicals (EDCs): Potential Sources and Impacts on the Australian Riverine Environment

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Land & Water AUSTRALIA
research • development • innovation

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EXECUTIVE SUMMARY

In recent years compelling evidence has been accumulated showing that certain chemicals (e.g. estradiols, nonylphenol, bisphenol A, PCBs and some pesticides) at elevated concentrations can interfere with the normal functioning of endocrine systems and can cause reproductive and immune system problems in wildlife. These chemicals are generally referred to as Endocrine Disrupting Chemicals (EDCs). However, the risks of EDCs for the Australian environment are not clear. This is especially true for the riverine environment, as the sources of EDCs can be many and diverse.

It is very important that the scientific basis for managing this issue becomes established before alarmist reporting influences public opinion, so that rational decision making about the uses of a range of chemicals and wastes can occur. Consequently, Land and Water Australia (LWA), CSIRO and Environment Australia sponsored this workshop to bring together natural resource managers, regulators, researchers and other agencies interested in developing a better understanding of the risks to the Australian Environment.

The broad aims of the workshop were to assess the importance of rural sources of endocrine disruptors in Australian aquatic ecosystems, to identify research needs and priorities in Australia.

Selected invited participants from across Australia met for a day in Adelaide and discussed the EDC issue in the Australian context. These included representatives from the regulatory bodies, federal and state health agencies, natural resource managers, and the researchers from CSIRO and several universities.

Prior to this meeting a discussion document, which summarized the current knowledge on EDCs in relation to implications to the Australian riverine environment was circulated. On the day of the workshop, several participants made presentations on different aspects of EDCs and the potential impact on Australian environment.

In the first session the presentations provided the stakeholder's perspectives, including environmental, health, natural resource managers and researchers. The current research on EDC sources, environmental fate and their ecological impacts on ecosystem health were reviewed. In addition the emerging treatment technologies to remove EDCs from wastewater were also discussed.

This was followed by discussions on identification of sources of EDCs in Australian riverine environment, their importance and future directions. During this session an attempt was made to prioritise the different classes of EDCs based on several factors such as their potency, environmental concentrations, persistence and mobility in the environment. Despite the limitations of such a simple approach, it was considered to be useful starting point.

The participants then deliberated, in three separate groups, on the current state of knowledge on the sources of EDCs and their importance, the environment fate and attenuation processes and exposure pathways and ecotoxicological considerations for Australian fauna and flora.

The deliberations during the workshop led to several conclusions. The key messages were:

- At this stage there is no clear direct evidence of cause and effect relationship of EDCs on human health.
- In contrast, a considerable body of evidence is now available in the literature on the impact of EDCs on ecosystem health, warranting an assessment of risks of EDCs in the Australian environment.
- The current policy of various agencies to keep a "Watching Brief" on the issue is not adequate and there is a need to make a serious attempt to understand the risks and implications of EDCs in Australian environment.
- There is an urgent need to carry out a scoping study involving monitoring and screening of EDC to establish the likely levels of EDCs in Australian environment.
- The Australian flora and fauna are unique in nature (eg. marsupials) and this should be taken into consideration in any risk assessment process.
- There is a need to better coordinate the Australian research and other activities on EDCs at national level and to establish more active collaboration with international agencies.
- A sound and balanced approach of communication is needed to properly inform the public and to avoid alarmist media reporting.

BACKGROUND:

Since the publication of the book "*Our Stolen Future*" (Theo Colborn *et al*. 1996), public concerns about the adverse effects of chemicals on reproductive systems of wildlife and human beings have grown immensely. Recent media coverage, such as in *TIME* (October 30, 2000 issue), in which links between exposure to certain chemicals and endocrine disruption in humans (early puberty in girls) is hinted, has further enhanced these concerns. USGS has just published (Kolpin *et al.* 2002, *Environmental Science and Technology* 36:1202-1211) the results from a monitoring study on 139 streams of US, reporting 80% of streams contaminated with trace levels of pharmaceuticals, hormones and organic wastewater contaminants. *The Australian* (March 23-24, 2002), covered this under the headlines "Alarm as drugs flood waterways". Another research just published from the University of California - Berkeley, found that atrazine herbicide at 0.1 ppb caused endocrine disruption to a species of frog.

In recent years compelling evidence has been accumulated showing that certain chemicals (e.g. estradiols, nonylphenol, bisphenol A, PCBs and some pesticides) at elevated concentrations can cause disruption to endocrine systems and hormonal control of development in wildlife (Kavlock *et al.* 1996;. Jobling *et al.* 1998; Sonnenschein and Soto, 1998, SETAC, 2000; Damstra *et al.* 2002).

However, the implications for the Australian environment are not clear (Lim *et al.* 2000; Ying and Kookana, 2002). This is especially true for the riverine environment, as the urban wastewater is recognized as a significant source of EDCs. It is very important that the scientific basis for managing this issue becomes established before alarmist reporting influences public opinion, so that rational decision making about the uses of a range of chemicals and wastes can occur. Scientists and managers need to be proactive to constructively contribute to the debate.

Consequently, Land and Water Australia (LWA) and CSIRO are currently carrying out a literature review and attempting with limited resources a preliminary risk assessment of EDCs in the riverine environment of Australia.

AIMS AND OBJECTIVES OF THE WORKSHOP

The broad aim of the workshop was to assess the importance of rural sources of endocrine disruptors in Australian aquatic ecosystems, to identify research needs and priorities in Australia.

The specific objectives of the workshop were:

- to discuss the current knowledge on types and concentrations of EDCs in surface and groundwaters from Australia and overseas, and to summarise the hazard assessments made to date;
- to identify important sources of EDCs and associated chemicals that deserve closer attention under Australian conditions;
- to provide input to R&D and the regulatory agencies for developing strategies to address the EDC risks, if any.

WORKSHOP FORMAT

Selected invited participants from across Australia met for a day in Adelaide and discussed the above issue. Prior to this meeting a discussion document, which summarized the current knowledge on EDCs in relation to implications to the Australian riverine environment was circulated. On the day of the workshop, after brief presentations on current work in Australia, discussions were held to identify sources of EDCs in Australian riverine environment, their importance and future directions.

AGENCIES PARTICIPATING IN THE WORKSHOP

Selected invited participants from across Australia met for a day in Adelaide and discussed the EDC issue, in the Australian context. The Environmental Protection Agencies of NSW, SA and Queensland and Environment Australia, NICNAS of Department of Health and Ageing and SA Department of Health Services provided the health and regulatory perspectives during the workshop. Several Natural Resource Managers, namely Land and Water Australia, CRC for Water Quality and Treatment, Australian Water Quality Centre and SAWater participated in the workshop. The research teams represented at the workshop included those from University of Technology Sydney, University of NSW, University of South Australia, the CRC for Water Quality and Treatment, LandCare Research New Zealand.

A detailed list of workshop participants is provided in Appendix 1

NATURE OF DISCUSSIONS AND DELIBRATIONS

Prior to this meeting a discussion document, which summarized the current knowledge on EDCs in relation to implications to the Australian riverine environment was circulated. On the day of the workshop, several participants made presentations on different aspects of EDCs and the potential impact on Australian environment.

In the first session the presentations provided the stakeholder's perspectives, including environmental, health, natural resource managers and researchers. The current research on EDC sources, environmental fate and their ecological impacts on ecosystem health was reviewed. In addition the emerging treatment technologies to remove EDCs from wastewater were also discussed.

This was followed by discussions on identification of sources of EDCs in Australian riverine environment, their importance and future directions. During this session an attempt was made to prioritise the different classes of EDCs based on several factors such as their potency, environmental concentrations, persistence and mobility in the environment. Despite the limitations of such a simple approach, it was considered to be useful starting point.

The participants then deliberated in three separate groups on the current state of knowledge on the sources and their importance, the environment fate and attenuation processes and exposure pathways and ecotoxicological considerations for Australian fauna and flora.

SUMMARY OF WORKSHOP OUTCOMES

A preliminary assessment of the importance of different classes of EDCs

Chemical groups as EDCs considered here

- Hormones
- Alkylphenol polyethoxylates
- Prescription/ Non-prescription Drugs
- Pesticides
- Disinfectants
- Metals

Rating categories and scores:

Low =1
Medium = 2
High =3

The rating table for different class of EDCs.

Factors Rated	Hormones	APEs	Drugs	Pesticides	Disinfectants	Metals**
Sources	3	3	1	3	2	2
Environmental concentrations	2	3	1	2	2	2
Potency	3	2	3*	1	1	1
Persistence	1	2	2	2	3	3
Mobility	2	1	2	2	3	1
Bioconcentration potential	2	3	2	2	1	1
Removal during treatment	NA***					
TOTAL	**13**	**14**	**13**	**12**	**12**	**11**

*3 with synthetic hormones otherwise 1
** Except TBT
*** Poor information

Limitations/ Reservations

1. Engineered treatment efficiency rating to be included.
   i.e. not removed, partially or completely.
2. Within a category a large spread of rating factor is possible.
3. Exceptions within different categories exist.
4. The table is of little value from the regulatory perspective.

- General acceptance of the approach
- Hana Hamdan: not agreed with system of rating
- Peter Dillon: suggested look at overall basis to get gaps of knowledge

Identified key groups

Hand voting on relative importance:

1. Hormones
2. Alkylphenol polyethoxylates (APEs)
3. Pesticides
4. Metals

PRIORTY RESEARCH / MONITORING ISSUES FOR EDCs IN AUSTRALIA

I. EDCs source and related priorities

1. Identify and quantify important sources of EDCs in Australian riverine environment. A risk based approach may be useful.
2. Develop/adapt standard and appropriate monitoring protocols and sensitive analytical techniques.
3. Identification of important EDCs for Australian environment.
4. Scoping study on the levels of EDCs in the environment.
5. Assess removal efficiencies of the current treatment technologies and develop more appropriate technology.

II. Environmental fate and transport pathways related priorities

1. Identify key chemicals deserving closer scrutiny.
2. Establish persistence and rates of breakdown, including biotic and abiotic degradation in the Australian environment.
3. Sorption, release and mobility in soil, sediment and water need to be established.
4. Bioavailability, bioconcentration/bioaccumulation need consideration.
5. Role and importance of breakdown products need to be established.

III. Exposure and receptor organisms related priorities

1. Recognise uniqueness of Australian flora and fauna (e.g. marsupials)
2. Select a suite of organisms from different phyla and trophic levels.
3. Adapt overseas testing protocols to Australian fauna and flora.
4. Develop a comprehensive understanding of the biology of study organisms.
5. Holistic approach is needed: molecular level to whole organism to population effects.
6. Validation of laboratory testing under field environments.

IV. Other priority issues.

1. An appropriately resourced and nationally coordinated approach is needed.
2. Collaborations with international agencies need strengthening.

V. Other issues raised during the workshop.

1. Cooperation on running the "Watching Brief" across state EPAs and other agencies is warranted. A single agency's effort may cater for all.
2. Impact of EDCs on coral polyps, dugongs in the Great Barrier Reef.

WHERE TO FROM HERE: SOME SUGGESTIONS FOR FUTURE

1. Funding is a major issue. Raise the profile of the issue.
2. Establish potential size and extent of the problem in Australia.
3. Targeted screening type monitoring may be useful.
4. Strategic and multidisciplinary approach is needed.
5. Pool necessary expertise and critical mass and develop cohesive projects.
6. Publish the findings in peer-reviewed journals.
7. Appropriate medium of communication need to be identified. A well-maintained web site is needed to cover the most appropriate and scientifically sound information.
8. Careful media handling is needed. Avoid sensationalisation of the issue and "alarmist media" approaches.

REFERENCES

Colborn, T., Dumanoski, D. and Myers, J.P. (1996). 'Our Stolen Future'. (Plume/Penguin Book: New York.).

Damstra, T., Barlow, S., Bergman, A., Kavlock, R. and Van Der Kraak, G. (2002). Global assessment of the state-of-the-science of endocrine disruptors. WHO/PCS/EDC/02/2.

Jobling, S., Nolan, M., Tyler, C.R., Brighty, G. and Sumpter, J.P. (1998). Widespread sexual disruption in wild fish. *Environmental Science and Technology* **32**, 2498-2506.

Kavlock, J.R., Daston, G.P., DeRosa, C., Fenner-Crisp, P., Gray, L.E., Kaattari, S., Lucier, G., Luster, M., Mac, M.J., Maczka, C., Miller, R., Moore, J., Rolland, R., Scott, G., Sheehan, M., Sink, T. and Tilson, H.A. (1996). Research needs for risk assessment of health and environmental effects of endocrine disruptors: a report of the US sponsored workshop. *Environmental Health Perspectives* **104**(suppl. 4), 715-740.

Kolpin DW., Furlong, ET, Meyer, MT, Thurman, EM, Zaugg SD. Barber, LB. and Buxton, HT. (2002). Pharmaceuticals, Hormones and other organic wastewater contaminants in U.S. streams, 1999-2000: A national reconnaissance. *Environmental Science and Technology* **36**:1202-1211

Lim, R., Gale, S. and Doyle, C. (2000). Endocrine disrupting compounds in sewage treatment plant (STP) effluent reused in agriculture – is there a concern? In "Watrer Recycling Australia" (P. J. Dillon, ed.). pp. 23-28. CSIRO &AWA, Australia.

SETAC (2000). Endocrine disruptors and modulators technical issue paper. Pensacola, FL, USA.

Sonnenschein, C. and Soto, A.M. (1998). An updated review of environmental estrogen and androgen mimics and antagonists. *Journal of Steroid Biochemistry and Molecular Biology* **65**(1-6), 143-150.

Ying, G.G. and Kookana, RS. (2002). Endocrine disruption: an Australian Perspective. AWA Water Journal **29**(9), 42-45.

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We are very grateful to contributors to the workshop who travelled from far and wide, and shared their experiences and vision on this important topic.

Thanks to several members of CSIRO, namely Anu Kumar, Marianne Woods and GG Ying, who worked hard to make this workshop a success.

Special thanks to Dr Peter Dillon who facilitated the discussion during the workshop.

APPENDICES

APPENDIX 1

List of Participants for the EDC workshop 28th June 2002, CSIRO Adelaide.

Name	Organisation	Email contact
Dr Ajit Sarmah	Landcare Research, New Zealand	SarmahA@LandcareResearch.co.nz
Dr Andrea Schäfer,	University of NSW, Sydney	a.schaefer@unsw.edu.au
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Ms Kathy Thomas	Department of Human Services, Adelaide	kathy.thomas@dhs.sa.gov.au
Ms Marianne Woods	University of SA, Adelaide/ CSIRO Land and Water	Marianne.Woods@csiro.au

Apologies:

Mr Chris Lee-Steere	Environment Australia, Canberra	Chris.Lee-Steere@ea.gov.au
Dr Gary Fan	Environment Australia, Canberra	Gary.Fan@ea.gov.au
Mr Keith Craig	Vivendi Water, Sydney	kcraig@vivendiwater.com.au

APPENDIX 2
Program
A one-day workshop on:
Endocrine Disrupting Chemicals (EDCs):
Potential Sources and Impacts on the Australian Riverine Environment

Waite Campus, Urrbrae 5064, South Australia
28th June 2002

	Setting the scene
9:00-9:25	Arrival - Tea/Coffee
9:30	Introductions
9:40	Workshop Objectives – Rai Kookana, CSIRO
	STAKEHOLDERS' VIEWS
9:50	Land and Water Australia – Dr Nick Schofield, LWA, Canberra
10:00	Environnemental Perspectives – TBA, Environment Australia, Canberra
10:10	Health Perspectives – Ms Hana Hamdan, NICNAS, Sydney
10:20	Water Recycling – Dr Paul Sherman, Qld EPA, Brisbane
10:30	Aquifer Storage and Recovery – Dr Peter Dillon, CSIRO
10:40	Tea/Coffee
	The current state of play
11:00	Overview of Sources and Environmental Fate of EDCs – Dr Guang-Guo Ying, CSIRO
11:15	EDCs in sewage effluent – Dr Richard Lim, UTS, Sydney
11:30	Animal Sources of EDCs – Dr Ajit Sarmah, CRI, New Zealand
11:45	Ecosystem Health Impacts – Dr Anu Kumar, CSIRO and Ms Marianne Woods, Uni SA, Adelaide
12:05	Removal Technologies – Dr Andrea Schafer, UNSW, Sydney
12:20	Biosolids Research in Australia-Dr Mike McLaughlin, CSIRO
12:30	**LUNCH**
	IMPLICATIONS FOR AUSTRALIAN RIVERINE ENVIRONMENT AND FUTURE DIRECTIONS
13:30	EDCs in Australian Riverine Environment – Rai Kookana
13:50	**Group Discussions** on Sources, their importance and risks to Australian Riverine Environment
15:00	**Tea/Coffee**
15:20	**Group Discussion** on Recommendations for Land and Water Australia and other agencies.
16:30	**CLOSE**

APPENDIX 3

List of attachments

1. **Endocrine Disruption – An Australian Perspective – A paper published in Journal of AWA – Water, Vol 29(9) 2002.**
2. **Description of European COMPREHEND Program on EDCs.**