THE HYDROLOGICAL SOCIETY OF S.A. INC.

c/o Water Resources Branch
Box 1751, Adelaide, S.A. 5001
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GUEST EDITORIAL : GREENHOUSE '88

If there were any members of the Hydrological Society unaware of the Greenhouse Effect (GHE) until recently, it is unlikely they would have remained in blissful ignorance through the last few weeks. Media interest, stimulated by the Greenhouse '88 Conference, has been intense.

If brief, the GHE is caused by the release of radiatively active or greenhouse gases (GHG) into the atrmosphere. The principal GHG's are carbon dioxide, methane, nitrous oxide, and carbonaceous fuels, the decay of organic wastes (e.g. in landfills) and the use of CFC's in, and loss from, refrigeration and air conditioning equipment.

These gases readily transmit the high frequency heat radiation coming from the sun, but do not so readily transmit the low frequency thermal radiation from the Earth's surface. As a result the Earth's surface air temperature is thought to be rising, and is certainly expected to rise in future as the atmosphere adjusts to its new and changing circumstances.

GHE is certainly an issue for Hydrological Society members. A change in total annual average rainfall, a redistribution of rainfall from one season to another or a change in rainfall intensity all have hydrologic consequences. An increased temperature will increase evaporation. Increased CO_2 levels alone may decrease evapotranspiration.

The global climatic models used to make predictions about climate change are necessarily very coarse and their ability to predict effects at the regional scale is limited. Whereas in south western Western Australia and much of New South Wales there are well established rainfall trends, in South Australia the trends are weak. Within an area extending from southern Eyre Peninsula across the Central Districts to the Murray Mallee and the Upper South East, the average winter (April to October) rainfall has been about 10% less in the last 50 years than it was in the previous 50 years. By contrast the winter rainfall has slightly increased to the north of this band and along the southern coasts and the lower South East.

It appears highly questionable whether these changes are not within normal climatic variability for South Australia.

In these circumstances of very high uncertainty, what should we in South Australia do? Perhaps the first thing to observe is that short term benefits for some activities will arise in certain regions. For instance increased summer rainfall in South australia's north may have agricultural benefits. However, at the global level, and in the longer term, the consequences are likely to be extremely disruptive.

The first element of our strategy should therefore be limitation - that is, doing all within our power to cut down South Australia's contribution of greenhouse gases. Measures would include improving the efficiency of electric power generation, substituting solar and wind power for fossil fuel, improving efficiency of end use of energy and simply using less energy. The use of CFC's would be phased out altogether, or they would be replaced by much less damaging alternatives. The argument that we in South Australia can contribute so little to a reduction in the GHE as to be of no consequence has to be rejected. Indeed it is merely another face of the argument which has created the present situation. The 'insignificant' few kilograms of carbon dioxide per year for which each South Australian is responsible adds up to megatonnes when multiplied by world population.

The second element of our strategy should be pre-emptive adaptation, that is, adopting now those practices which will enable us to better cope both with our present hydrologic regime and with likely changes. An example is in handling stormwater which may present a greater problem as a result of increased summer rain. At present we maximise the urban run-off problem by making three quarters of the surface of built-up areas highly impervious (roads, roofs, driveways). At the same time we deny our gardens and parklands most of this free gift of water, and enormously reduce opportunities for aquifer recharge. As our editor John Argue has advocated previously in these pages, we can make use of stormwater by storing it in the soil of our gardens. In our new suburbs we can maximise opportunities for detaining rainwater locally by using narrower roadways, and using grassed swales instead of concrete road gutters.

The third element of our strategy should be monitoring. We need to establish a sufficient number (and maintain in the face of persistent demands by government for further cut-backs) of high reliability weather monitoring stations so that any change in regional climate is detected as soon as practicable. In addition we need to monitor streamflow in a few catchments, to see how our catchments are responding to climate change. Because streamflow is the residual left over from rainfall after catchment processes have operated, it will be a more sensitive indicator of Greenhouse effects than rainfall itself. It will certainly be the more significant indicator of water resource trends, provided we also monitor land use changes occurring in the catchment. The ideal place for such long term monitoring is in places where land use changes should not occur - e.g. in National Parks.

The above ideas, among others, were discussed by the Water Resources Workshop at the Greenhouse '88 Conference. In relation to the media hype, they may seem very low key. However the first element, though not exclusively related to hydrological consequences of climate change, could profoundly affect the way in which we conduct our daily lives.

JOHN ROLLS

FROM THE HYDROLOGICAL TRAPS.....

MAJOR IRRIGATION STORAGES IN THE CLARE AREA

[Reporter : C. M. Purton]

The boom in export prospects for Australian wines has prompted one wine company to decide to irrigate its vineyards in the Clare Region. The yield of irrigated vines is expected to double compared to vines grown under a natural rainfall regime.

B. C. Tonkin & Associates were commissioned to undertake preliminary catchment water yield studies for the dam. Following the successful completion of these studies the project went ahead. The size of the dam was fixed at 400 ML.

The dam is an off-line storage dam, filled by pumping from a small diversion weir on the main stream. The advantage of this arrangement is the the storage dam is sited on a very small catchment, thus minimising peak flows from extreme rainfall events. The dam is classified as a "large dam" under the ANCOLD "Guidelines on Design Floods for Dams, 1986". The ANCOLD Guidelines lay down stringent requirements on the rainfall recurrence intervals for designing spillways for large dams. Minimising the peak flows allows for substantial savings in spillway construction costs.

The dam is currently being constructed near Watervale under the supervision of B. C. Tonkin & Associates.

SIMULATION OF DOMESTIC ROOF RUNOFF AND WATER CONSUMPTION

[Reporter : C. M. Purton]

The Bureau of Meteorology can now provide meteorological data on floppy discs in standard MS-DOS format. B. C. Tonkin & Associates have taken advantage of this to run a domestic roof water balance simulation for 40 years of rainfall data in the Adelaide Hills.

The roof runoff is calculated using regressions developed by Ian Laing (Department of Agriculture, W.A.) as reported at the 1988 I.E. Aust. Hydrology Symposium. Multiple program runs have been conducted to find the optimum rainwater rank size for a range of assumed daily drawdowns and roof areas. The cost of carting water during drought years is also calculated. This method allows greater precision in estimating their variables than does the method presented in the booklet "Rain Water Tanks" published by the E. & W. S. in 1981.

3rd INTERNATIONAL MINE WATER CONGRESS

[Reporter : Don Armstrong]

The 3rd International Mine Water Congress was held between 23rd and 28th October in Melbourne. The congress was organised by AusIMM on behalf of the international Mine Water Association.

170 delegates drawn from 20 countries attended technical sessions in which 90 papers were reviewed by general rapporteurs, followed by 5 minute responses from authors.

Subject matter covered the entire range of topics in the field of water related to mining. It is of interest to note that over the past 3 congresses (held at 3-yearly intervals), the percentage of papers relating to water management and environmental impacts of mining and mining waste disposal, has increased from 27% to 37%. This is an indication of the increasing awareness of the mining industry that the sustainable future of the world's water resources must be considered when evaluating mining

intensive work effort aimed at control of acid mine drainage supported by the "Super" fund in the U.S.A.

The proceedings of the Congress are available from AusIMM and make worthwhile reading for anyone interested in mine water problems.

21st CONGRESS OF THE INTERNATIONAL ASSOCIATION OF HYDROGEOLOGISTS

[Reporter : Peter Smith]

(Karst Hydrogeology & Karst Environmental Protection)

The congress was held between 9 and 16 October in Guilin City, Gaungxi Zhuang Autonomous Region, southern China. Primary sponsors were the China National Committee for IAH and the Geological Society of China. Over 400 persons from more than 40 countries attended, with a little less than half the attendees coming from outside China.

The first couple of days were devoted to plenary sessions where simultaneous translation was used (English was the conference language). The conference was punctuated on the third day by a boat trip along the Lijiang River. The final three days were subdivided into three concurrent sessions in various specialist areas; karstology, general hydrogeology, pollution, environmental protection, isotope studies, etc. The standard of papers both in content and presentation varied over a very wide range!

Following the conference four Post-Congress excursions were on offer. Your correspondent and his two travelling compansions (Steve Barnett and Andrew Love - all primarily self-funded!) chose No. 2 to Kunming, Yunnan Province, an area noted for its minority groups and Stone Forests.

The three of us exited through Gaungzhou, Hong Kong and Bangkok where we met Nick Kontos (ex E. & W.S. Water Resources Branch) who is working on a village water supply project in northern Thailand adjacent to the Laos border.

Nick escorted us around his project area between Khon Kaen and the Mekong River, an area of rice, sugar, cassava growing and eucalypt plantations. Nick still receives his HSSA Newsletter and Notice of Meeting albeit sometime after the event. Thai food washed down with Mekong whisky and soda is recommended.

For those interested in karst hydrogeology, the proceedings are available for perusal from any of the three above-mentioned attendees.

SHORT COURSE ON GROUNDWATER HYDROCHEMISTRY

INTRODUCTION

A course on Groundwater Hydrochemistry : Principles, Applications and Practice, will be held in Adelaide from 13-16 February 1989. The course is directed toward those individuals who seek to develop the necessary methods for utilising hydrochemical and isotope data in groundwater research, resource management and water quality investigations.

The four-day course will cover fundamentals of the geochemistry of natural waters and then lead to more complex problems involving geochemical modelling using the USGS programs WATEQ and PHREEQE. About half of the time will be involved in formal lectures while the remainder will be devoted to hands-on analytical procedures for field sampling and problem solving of case-histories. Some aspects of isotope hydrology will be presented at the end of the course.

REGISTRATION AND INFORMATION

Please register your intention to attend the workshop as soon as possible, but no later than December 16, 1988.

For further enquiries contact Dr. Peter Dillon, at Centre for Research in Groundwater Processes.

Telephone (08) 274.9311 or 274.9381.

IMPORTANT NOTICE

VISIT BY PROF. JACOB BEAR

JANUARY 23, 1989

Jacob Bear of the Technion (Israel Institute of Technology) is an international figure in the fields of groundwater hydraulics, solute transport and modelling.

He will be visiting Adelaide on Monday January 23 1989, and a meeting with those interested in these fields is being arranged by the Centre for Research in Groundwater Processes. The meeting will take place at the S.A. Dept. of Mines and Energy conference room (Greenhill Road).

For further information and to indicate your interest, please contact Peter Dillon on 274.9381.

SPECIAL ARTICLE : WATER QUALITY INDEXES

(Reproduced from "Streamland 65", N.Z. National Water and Soil Conservation Authority.)

A New Index System

Recently the Water Quality Centre has undertaken work to produce an indexing system for water management without the inherent weaknesses of earlier overseas versions. Early on in the work a decision was made to produce suitability-for-use indexes based on something specific, definable, and meaningful to water managers, politicians and lay people. The question, "how suitable is a particular water for certain uses?", would be addressed and, hopefully, answered.

Four indexes have been devised for rivers and streams and are termed General, Bathing, Water Supply, and Fish Spawning Indexes. A detailed description of the water uses considered is given in Table 1. Three of the indexes specifically cover multiple water uses although this is not apparent from their names. Bathing and Supply waters, for instance, are also to be protected for aquatic life.

The indexes are based on proposed new water legislation contained in the second schedule to the June 1986 Draft Water and Soil Conservation Bill. This is another feature of the indexes which distinguishes them from overseas systems. It was felt that linking them with proposed legislation and its associated classification system would make them more acceptable. But use of the indexes is not dependent on this proposed legislation becoming law. All that is required is that the waters are to be managed for the same purposes as given in Table 1.

However, the most important feature of the New Zealand Indexes is the way the sub-index values are aggregated. More on that later!

How were the Indexes Developed?

A panel of 18 water quality experts of differing backgrounds was convened to provide the Index designer with a range of expert opinion. The development process had several phases (see Figure 1), and although it seems simple enough, it was a tedious and lengthy procedure.

The technique employed to obtain the information is called the Delphi Method. This uses a series of questionnaires to elicit a group response. An important feature of the Delphi Method is that at each stage subsequent to the first, panel members are sent the pooled group response for the preceding stage and the individuals are asked to reassess their previous response. This is an attempt to improve consensus, that is, to produce convergence of opinion. Anonymity between the panel members is preserved and communication is by mail. Five questionnaires were used.

TABLE 1

Water uses for the four suitability-for-use water quality indexes. This information is derived from a 1981 report of the Water Quality Criteria Working Party. The uses are for waters which could be classified G (General), R (Regular Public Bathing), S (Water Supply), and F Fish Spawning).

General Water Use Index :

General use waters have no singled-out principal use, but are subject to competing uses. The waters would be protected and maintained for:

a) a substantially unaltered aquatic community;
b) the general aesthetic amenity;
c) fishing;
d) stock watering;
e) irrigation;
f) public water supply after extensive treatment;
g) occasional contact use such as swimming;
h) waste assimilation.

Regular Public Bathing Index :

This index is for waters which are regularly used for public bathing. Other uses, and in particular aquatic life, are also protected.

Water Supply Index :

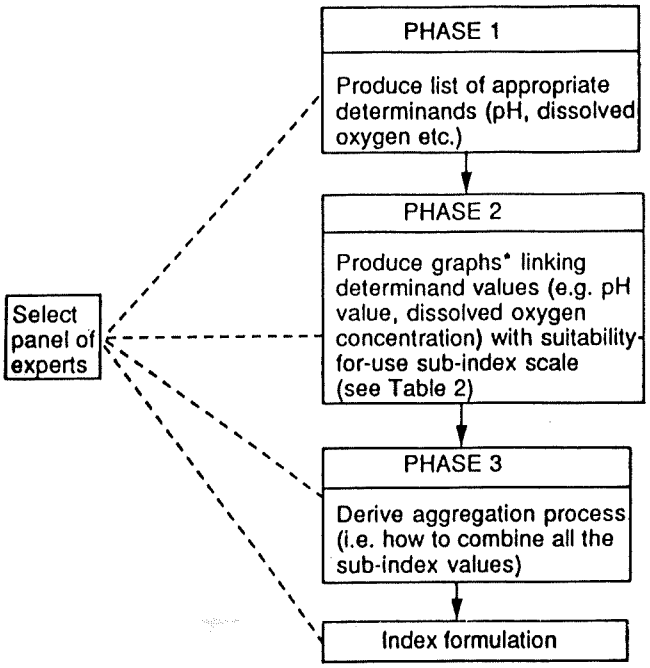
In this instance the waters may receive considerable treatment prior to use as potable supply and/or for food preparation/processing. Aquatic life is also protected but at a lower level than for Bathing and Fish Spawning waters.

Fish Spawning Index :

This index is for waters specifically protected for fish spawning purposes. For simplicity, the index covers salmonid spawning waters.

The determinands finally agreed upon (phase 1) for each of the four indexes are given in Table 3. They are very familiar and comprise some of the commonly measured aspects of water. Toxic substances are not included because a wide range of different chemicals would have to be measured, and in practice New Zealand waters are rarely toxic.

The sub-index curves (phase 2) were obtained as follows. Blank graph formats were supplied to the panel members. The x-axis represents the



*Examples of graphs (sub-index curves) are given in Figure 2

Figure 1: Development of the indexes

TABLE 2

Descriptors for the range of sub-index values (I_{sub})

$0 \leq I_{sub} < 20$	Totally unsuitable for main and/or many uses.
$20 \leq I_{sub} < 40$	Unsuitable for main and/or several uses.
$40 \leq I_{sub} < 60$	Main use and/or some uses may by compromised.
$60 \leq I_{sub} < 80$	Suitable for all uses.
$80 \leq I_{sub} < 100$	Eminently suitable for all uses.

expected range of determinand values likely to be encountered in New Zealand during non-flood conditions. The y-axis ranged from zero to 100. This is the suitability-for-use axis (sub-index values, I_{sub}). Panel members were supplied with a mutually agreed set of descriptors for the range of sub-index values (Table 2) and asked to draw an appropriate curve covering the range of determinand values. That is, they were asked to indicate graphically what the sub-index value (and hence suitability-for-use) should be at, for example, pH 3, 4, 5 and so on. Thus a water pH considered absolutely suitable for all designated uses would score 100, whereas a water totally unsuitable for the main and many uses could score as low as zero. In all, thirty-two curves were requested.

In some cases (i.e. where in proposed legislation a numerical standard is given) the curves had to go through a fixed point (the standard's value and I_{sub} = 60; this corresponds to the lowest value in the "suitable for all uses" category - see Table 2). For instance, in the proposed schedule for bathing waters, the pH must not fall below 6.5, nor must it rise above 9. These are fixed points in the pH sub-index graph at (6.5, 60) and 9.0, 60).

The curves drawn by the panel members were then averaged to produce the final graphs. This was accomplished by taking about 20 points along the x-axis of each individual curve, obtaining sub-index values and arithmetically averaging them over the whole panel. New curves drawn up using these averaged points were returned to panel members for comment and approval. Three exmaples of the final curves for the Bathing Index are given in Figure 2.

Initially there was a wide divergence of opinion on which determinands should be used for each index and on the relationship between determinand values and a water's suitability-for-use. For instance, for suspended solids in Bathing waters, sub-index values given by panel members ranged from 29 to 100 at a suspended solids concentration of 15 g/m^3. This means that such waters were perceived as ranging from "unsuitable for the main and/or several uses" to "eminently suitable for all uses". Clearly even scientists' perceptions vary greatly.

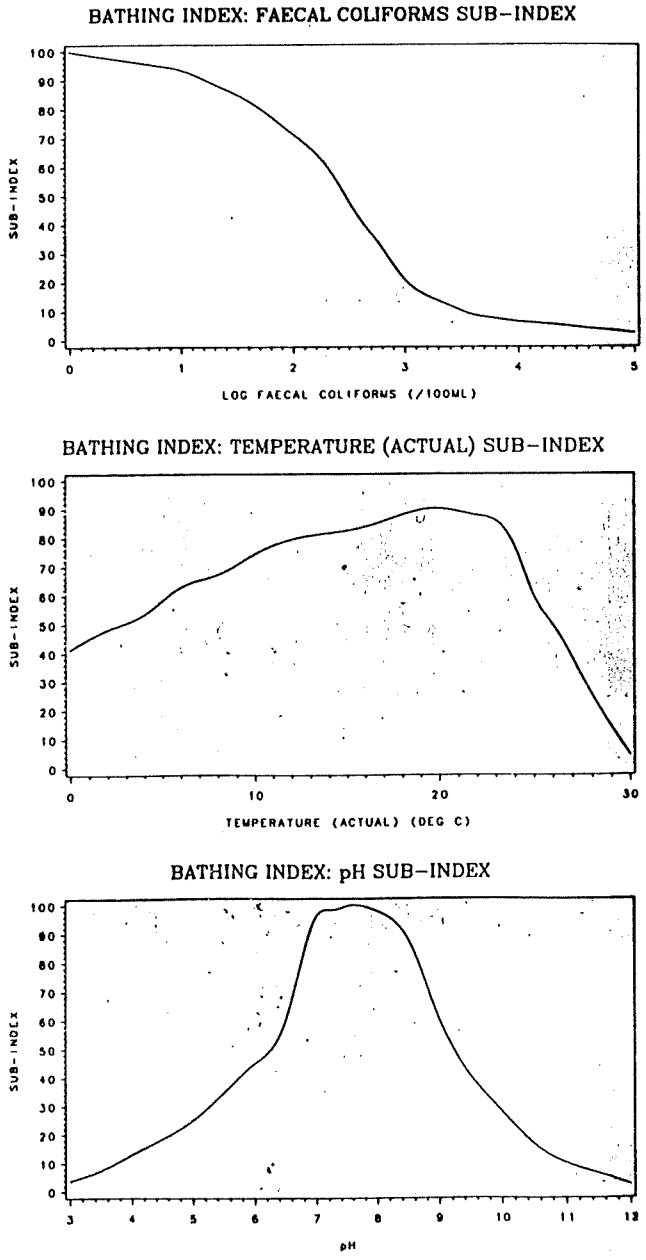


Figure 2: Three examples of sub-index curves from the Bathing Water Index.

Having produced a mechanism for obtaining sub-index values from determinand values, the major problem remained of how to aggregate them to produce a final index score. This is phase 3 in Figure 1. As noted earlier, overseas techniques have significant drawbacks and a new system was needed.

Many complicated mathematical functions were tried but proved unsatisfactory. An extremely simple system was finally decided upon. Because a water's suitability-for-use is largely governed by the "poorest" characteristic, why not use it to produce the final index score? This concept is similar to the limiting nutrient idea in eutrophication studies where one component defines the state of the water. Using it in the example given earlier (low pH in an otherwise satisfactory water) would produce a low index score, with the water being seen as unsatisfactory for bathing and many other uses. This is surely the whole purpose of a suitability-for-use index system : to specify in a simple manner how suitable a water is for its defined or proposed uses.

Use of the indexes

For a particular water body we first need to know which use category it is managed for as this will dictate the choise of index. Of course, for a particular water, all four indexes could be calculated to see what uses the water is suitable for. Then values are established for the appropriate set of determinands and these in turn are used to produce sub-index values from the sub-index curves, the lowest of which is the final index score. For an example see Figure 3.

To make life a little easier when deriving sub-index values, tables relating them to determinand values have been produced; computer software to do this is also available.

Occasionally, apparent "oddities" are produced. For example, suppose the temperature of a bathing water is 26.5°C, corresponding to a sub-index value of 44 and that this is the lowest sub-index value. This also then is the index score for the water which will fall into the category "main use and/or some uses may be compromised". Although this may seem strange for bathing waters, remember that it is also to be protected for aquatic life. At this temperature some fauna (e.g. trout) are likely to be stressed : the index is telling us something useful about the water. The temperature sub-index curve for bathing waters is obviously a compromise curve. In fact it never reaches 100. This means that if a water has multiple designated uses, it may never be "perfect" for all its uses.

TABLE 3

Determinands used in the four indexes

	General	Regular Public Bathing	Water Supply	Fish Spawning (Salmonids)
Dissolved oxygen	X	X	X	X
pH	X	X	X	X
Suspended solids	X	X	X	X
Turbidity	X	X	X	X
Temperature*	X	X	X	X
BOD_5 (unfiltered)	X	X	**	X
Ammonia			X	
Faecal coliforms	X	X	X	

* Both the actual water temperature and the elevaltion above natural are required. In most instances the latter can probably be assumed to be zero.

** Although BOD_5 is not in the Water Supply Index list, it may be included if local conditions warrant it.

What next?

The development of the indexes and a guide to their use has recently been published, in the Water quality Centre Publication Series (No. 12). The real value of the indexes can only be gauged after rigorous testing by water authorities and other interested parties over the next year or so. In future, we can anticipate a time when tried and tested indexes will be in common use as water management tools.

As well as advertising the availability of the indexes, this publication also requests that they be tried, and that comments be passed on to the Water Quality Centre.

Further information

Further information can be obtained from the Scientist in Charge, Water Quality Centre, P.O. Box 11-115, Hillcrest, Hamilton. This leaflet is based on the work of Dr. D. G. Smith.

Water use : Regular Public Bathing

Determinands required to be measured	Values obtained	Sub-index values
Dissolved oxygen (g/m^3)	7.7	90
pH	8.5	86
Temperature (°C)	23.5	80
Temperature above natural (°C)	0.0	100
Suspended solids (g/m^3)	24	36
Turbidity (FTU)	12	34
Biochemical oxygen demand (g/m^3)	1.5	89
Faecal coliforms (median of 5 samples: no./100 ml)	912	23

Final Index score	Suitability-for-use descriptor
23 (due to Faecel coliforms)	Unsuitable for main and/or several uses

FIGURE 3 - An example of how an index score is obtained

FROM THE SECRETARY.....

The Executive Committee met in early November to decide on a programme of meetings for 1989. There will be 6 meetings, and the topics are listed as follows:

February 16th - The Woolpunda Scheme, and the Anger-Bremer Basin.

April 13th - Hydrology and Water Quality. (Richard Clark)

June 15th - On-Site Detention and Urban Stormwater issues. (John Argue)

August 10th - Light attenuation in water and related issues. (Alison Turnbull)

October 12th - Domestic wastewater disposal, Land Capability and Water Resources Planning.

November 30th - Hydrology overseas, Oman and Turkey.

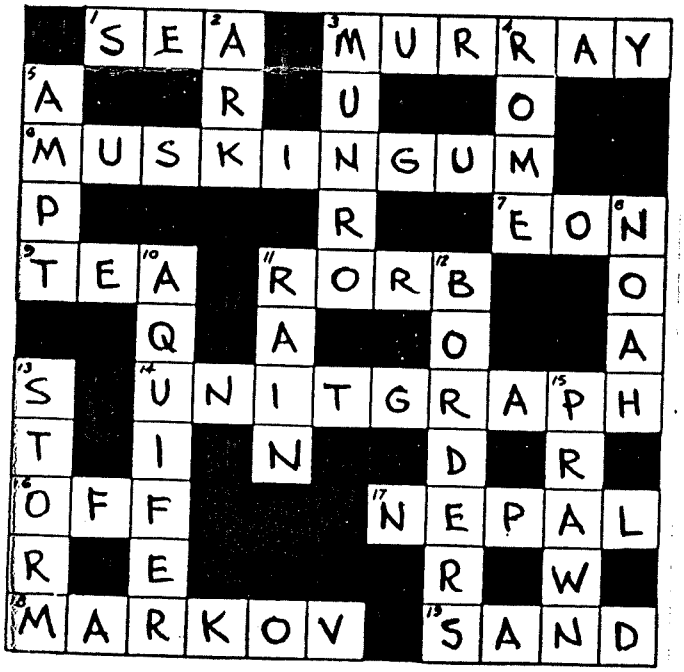
These topics were selected from an initial list of 19. It is encouraging to see such a wide range of subjects which come within the field of interest of the Society.

The topic for the meeting in November, which was to have been on Irrigation practices in Thailand (Peter Hoey and Tony Read) has had to be changed to a Danish setting, and the talk will be given by Anne Jensen who has just returned from one year's research into wetland areas there. The meeting will be of general interest and members may wish to bring wives/husbands and kids. This will be the last meeting of the year and will be something of a social event. Drinks will be provided free of charge!!

Preparations are under way for publicising the Ian Laing Prize which is open to final year students at tertiary institutions, who are studying subjects related to hydrology. The standard of applicant for the prize has been very high. However the number of applications has been limited, and we hope that we will attract a wider range of students next year.

The new Australian Rainfall and Runoff document has now been available for one year. It is a comprehensive and valuable aid to civil engineering and hydrological design. However to the uninitiated, the sheer size of the book is a little daunting. Fear not! Help is at hand!

A workshop on the new document is being planned for mid-July 1989. We expect that Dr. Ian Cordery from the Department of Civil Engineering, University of New South Wales, will run a two-day course. Anyone who has already attended the Graduate Certificate Course at U.N.S.W. will know that the workshop will be extremely hard work, and that there will be lots of worked examples of a wide range of hydrology problems to study. We expect that the cost will be of the order of $300. Keep an eye on the Newsletter for more information, or contact the Secretary on 366.2269.



Solution to the September' edition's crossword. Any offers for a Hydrological Crossword in 1989 ?

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