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THE GSI GROUNDWATER NEWSLETTER

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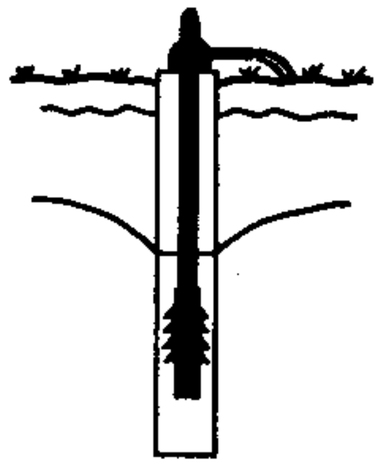

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IN THIS ISSUE

"Drought Looms Again" and **"The Fight for Water"** are typical headlines in both the British media and engineering technical journals in recent weeks. Evidence from GSI water level recorders suggest similar problems here in Ireland unless there is significant recharge in later July and August, which is unlikely. John Sweeney's article on page 2 suggests that **future climatic change** may result in **longer drought periods.** Now must be the time to start planning for this situation. The increased use of groundwater particularly for emergency supplies is an obvious solution as they can be developed far more quickly and cheaply than surface schemes. For local authorities and group schemes using **spring sources** there are two short term solutions. Firstly overflows (if there are any) should be reduced as much as possible by raising or damming the outlets. Secondly the springs could be deepened and the pump lowered so that groundwater storage is used more effectively.

On page 4 Richard Thorn starts a series of articles on **toxic wastes** which will give us the up-to-date situation in the rest of Europe. On page 6 Kevin Longworth describes the investigation for a **waste disposal site in Wales.** On pages 7-10 there are the usual **Newsletter** items - **News from Abroad, I.A.H. News** and **Local News.**

There was a big response to the Questionaire sent with the last issue of the **Newsletter** so thanks to all who returned it. Your views and suggestions will be reflected from the next issue on.

Articles for the next issue should reach me before 15th October.

Donal Daly, Geological Survey of Ireland.

CLIMATIC CHANGE

Irish Precipitation and the Greenhouse Effect

The recent Intergovernmental Panel on Climatic Change has supported the expectations of the overwhelming majority of climatologists that significant global climatic changes are imminent due to the rapid increases in the atmospheric concentration of greenhouse gases such as CO_2, Methane, Nitrous Oxides and Ozone. While the coarseness of grid size used in global circulation model outputs do not enable regional scenarios for climatic change to be predicted with any confidence as yet, and while feedback effects due to increased cloud, decreased ice cover and ocean mixing of excess atmospheric heat are as yet imperfectly understood, some broad agreement on a number of likely climatic changes are emerging. These conclusions are facilitated by the greatly enhanced computing power now being brought to bear on developing more sophisticated and realistic global circulation models (gcm).

A global temperature rise of 0.5degC within the next 15 years is likely, irrespective of what steps are taken to reduce CO_2 emissions. This would be equivalent to a departure of three standard deviations from the current 30 year average and, if realised, could be taken as strong evidence that model predictions for the future will be validated. For doubling of CO_2, now expected around 2040 a 2degC rise can be expected by comparison with present day values, a rate of change equivalent to a poleward movement of isotherms of 50-75km/decade. Warmer air holds more water vapour, about 7%/degC, so a warmed world is likely to be a wetter world overall. In many places though any extra moisture availability will be negated by higher evaporation.

Sea level has risen by 10-15 cms in the past century, and can be expected to rise by a further 25cms by 2030. This projected rise is not as alarmist as has been claimed in the past, but may be sufficient in magnitude and rapidity for significant changes in sedimentation rates in estuarial environments to occur and for problems of saline intrusion in coastal aquifers to become more pronounced.

Undoubtedly, global warming will weaken the westerly circulation and diminish the number of days in the year when this circulation type prevails across Ireland. Indeed the phenomenon may be considered to be already underway, with the number of true westerly days over Ireland having approximately halved over the past 50 years. Diminished westerlies would however be expected to be associated with increases in other circulation types from other directions, most notably from continental sources. In winter, even in a greenhouse world, this would bring colder air masses to Ireland more frequently than at present. Blocking could be expected to become more common and winters and springs in western Europe might not be expected to warm significantly from present values. Such a surprising scenario has been suggested from an examination of past warm analogues and is further demonstration of the dangers of simplistic interpretation of global climate models. It could be suggested Irish summers will also be affected by increased blocking frequencies for the same reason. However, this will cause increased warmth, perhaps 3degC by mid century, in agreement with current gcm predictions.

A decline in the westerly circulation frequency has also significant effects on precipitation. Geographical contrasts in the annual rainfall map are largely as a consequence of precipitation borne on westerly

circulations. With other circulations the distinctive west-east contrast diminishes. Increases in blocking in winter should mean less precipitation, though when the westerlies do blow they will be even more moisture laden than at present. Winter depressions are thus likely to pose an increased flood hazard for Ireland. The following tentative set of hydrological impacts for Ireland may be suggested for a doubled CO_2 scenario:

1. Summers will be significantly warmer (3 degC), though it is not at all clear whether they will be drier or wetter overall. Warmer summers in the past in Ireland have been drier and if this analogue is accepted, reductions in rainfall can be expected. At a maximum these would be about 15% though insignificant changes might be suggested for the south coast of Ireland. An increasing tendency for soil moisture deficits will exist in all summers, and longer spells of drought in the early summer months will be more common.
2. Winter temperatures may not be significantly different from the present. Springs may be slightly cooler. Winter rainfall will perhaps be slightly reduced in total and certainly less raindays will be the norm on the west coast. Flood hazard, especially in western Ireland will increase with the average intensity of winter rainfall showing an increase as time progresses.
3. The geographical contrast between western and eastern Ireland in terms of annual rainfall will perceptively diminish.
4. Increased variability will characterise Irish precipitation. The existing concepts of return period for rainfall amounts and intensities, and also river flow regimes, will thus require revision. This is because even small changes in mean climatic characteristics manifest themselves as larger changes in extremes. For example a climatic change which has a 1/100 probability of occurring has a 1/10 probability with a change in the mean of only one standard deviation. Fortunately Irish daily precipitation values have already a high standard deviation, and changes in frequency of high magnitude events will not approach this extreme case.

There is however one important caveat to all of this. That is that greenhouse climatic scenarios depend on the melting of considerable sea ice in the higher latitudes. The models do not offer any confidence regarding this either. Until this melting occurs however, the Equator-Pole temperature gradient may actually be increased, with the planetary circulation having to move greater amounts of heat polewards in the short term. It is thus possible that in the medium term, 10-30 years, more vigorous storm activity may characterise the north Atlantic and North Pacific, and enhanced hurricane developments in the tropical oceans could be a counterpart to this. Thus while a greenhouse warmed world may be more benign to Ireland than to almost any other mid latitude location, it may be preceded by major changes in storm frequency and intensity. It may be hazardous therefore to plan long life civil engineering structures on the basis of the 1961-90 climatic avaerages, either in terms of precipitation or wind climatology.

John Sweeney, Department of Geography, St. Patrick's College, Maynooth.

Thought for the Day: The Eleventh Commandment

"The earth is the lord's and the fullness thereof:
Thou shall not despoil the earth, nor destroy the life thereon".

WASTE DISPOSAL

Toxic Wastes in Europe - Parliament, People, Politics, Problems and Potential. 1 - The Wastes and their Disposal

"The disposal of hazardous wastes causes difficulties in all the Member States of the European Community: there is hardly a single country in which the disposal capacity is adequate"[1].

Strong words, but are they accurate? Are we as hydrogeologists, engineers and environmental scientists sufficiently aware of the hazardous waste industry and the way it operates? What can public opinion and changes in public opinion tell us about the nature of the problems we are going to have to solve?

In this series of articles I will attempt to answer some of these questions and will try a little 'crystal-ball gazing' to see in what areas we are going to have to improve our technical skills. Future articles will examine such topics as transfrontier shipments of wastes, contaminated sites, public opinion as a motive force in environmental issues and recycling and waste prevention.

So far in this article three terms have been used to describe the materials we are talking about; toxic wastes, dangerous wastes and hazardous wastes. Add to these some of the other terms - chemical wastes, special wastes, industrial wastes, problem wastes and poisonous wastes - and you get an indication of the nature of one of the basic issues that is involved; what exactly are we talking about? If we don't know what we are talking about how do we know how much of it we are generating?

The problem gets worse. Even though the Ânnex to Directive 78/319 (Council Directive on Toxic and Dangerous Waste) lists substances considered to be toxic or dangerous and thus requiring priority consideration, there is no reference to standards concerning concentrations of such substances. So different countries use different criteria to determine what is hazardous and what is not. Our own regulations[2] are vague when defining toxic and dangerous waste as "any waste containing or contaminated by the substances and materials listed in the Annex to the Directive of such a nature, in such quantities or in such concentrations as to constitute a risk to health or the environment". The proposed Council Directive on Hazardous Waste[3] goes some way to sorting out problems of nomenclature and definition of hazardous wastes by being more specific about the components and properties of wastes that make them hazardous but whether the changes will be enough remains to be seen.

Given the difficulties of definition and nomenclature can we make some estimate of the amounts of hazardous waste that arise in the European Community? Table 1 shows that hazardous waste accounts for approximately 1.5% of the total waste arisings in the European Community. How believable are these figures? A Committee of Inquiry of the European Parliament into toxic and dangerous substances[5] in 1984 estimated that "more than half of all dangerous wastes escapes the control of the authorities". Has the situation changed in the intervening years? The proceedings of a workshop on "Waste Management Beyond 1992" in April 1989[1] noted that in the Netherlands an estimated 10% of hazardous waste escapes control while in Denmark as much as 30% is unaccounted for. Clearly there are still problems in trying to account for all hazardous waste arisings, the main one being that many waste generators dispose of the waste themselves without recourse to local authorities.

Table 1
Tonnes of Waste Produced/Year in the European Community[4]

Type of Waste	Ammount
Household waste	90,000,000
Industrial waste (including hazardous waste)	160,000,000 (30,000,000)
Waste from extractive industries and power stations	400,000,000
Sewage sludge	230,000,000
Rubble	160,000,000
Waste oil	1,900,000
Agricultural waste	1,108,000,000
Total	2,150,000,000

In terms of the national share of the waste arisings, West Germany is by far the largest producer at 10 x 10^6 tonnes/year with Italy, the UK and France in the second division of waste producers[1] with a combined total of 10.6 x 10^6 tonnes/year.

Where does the waste go? As with the collection of data on waste arisings, it is difficult to assess exactly where the wastes end up. Actual disposal methods vary widely from one Member State to another. In general it tends to be the case that states with large surface areas show a higher preference for dumping (e.g. UK 85% dumped), while states with smaller surface areas show a higher share of incineration (e.g. Denmark with about 60% and the Netherlands about 50% incinerated) or export (e.g. the Netherlands with about 25%)[1].

References:

1. European Parliament - Committee on Energy, Research and Technology STOA Project (1989) Science and Technological Options Assessment Workshop on 'Hazardous Waste Management Beyond 1992'. English version. European Parliament L-2929 Luxembourg.
2. The European Communities (Toxic and Dangerous Waste) Regulations (1982) S.I. No. 33 of 1982.
3. Commission of the European Communities (1988) Proposal for a Council Directive on Hazardous Waste. Official Journal of the European Communities, No. C 295, 8-16.
4. European Parliament - Committee on the Environment, Public Health and Consumer Protection (1987) Report on the waste disposal industry and old dumps. Document A2-31/86.
5. European Parliament - Committee of Inquiry into the Treatment of Toxic and Dangerous Substances by the European Community and its Member States (1984) Report on the treatment of toxic and dangerous substances by the European Community and its Member States. Document 1-109/84.

Richard Thorn, Sligo RTC.

Landfill Site Evaluation - North Wales

On behalf of a major UK Waste Disposal Contractor, Acer Consultants Ltd (John Taylor and Sons and Freeman Fox and Partners) carried out a hydrogeological, geotechnical and mineral reserve assessment on the site of an existing clay extraction pit in North Wales. The site is bounded on three sides by the River Dee from which licenced abstractions take place for Wrexham, Chester and parts of Liverpool.

A site investigation was undertaken consisting of a desk study followed by a ground investigation comprising of a rock mass discontinuity survey, slope stability assessment, and a borehole investigation with in-situ permeability testing with subsequent laboratory testing of recovered samples. The desk study indicated the site is underlain by Upper Coal Measures Marl (massive mudstone) in faulted contact with Middle Coal Measuresinterbedded sandstone sand siltstones in the eastern and western limits of the proposed landfill area. These faults were conjectured to pass beneath the River Dee.

The bedrock is overlain by variable thicknesses of flood plain gravels, alluvium and glacial till.

A visual inspection of the site indicated that partial backfilling of the excavation area with silts from an adjacent coal washing plant had taken place. Discussions with the clay pit operators indicated no groundwater seepages had been observed and that working conditions were generally dry even though the pit floor was below the level of the river.

The results of the ground investigation were broadly consistent with conditions anticipated from the desk study. Boreholes were drilled to rockhead using a shell and auger rig, and subsequently extended to completion depth using rotary cored foam flush drilling techniques. Falling head permeability testing was carried out in uncased sections of all boreholes in the superficial deposits, and packer permeability testing was carried out in bedrock. Piezometers were installed in selected locations and all remaining boreholes were grounted up on completion. The boreholes were located in specified positions to investigate the nature and permeability of the superficial deposits, bedrock lithologies and the fault zones.

Based on the results of the investigation, a new layout of the existing clay extraction pit has been designed together with a containment landfill with gas and leachate monitoring chimneys and leachate collection systems. Capping and lining of the landfill will be carried out using on-site materials.

Kevin Longworth, Acer Geotechnics Ltd.,

I.A.H. NEWS

David Burdon Commemoration Lectures

Dr. Jaroslav Vrba, Czechoslovakia, will address the following seminars:-

1. Landuse planning and groundwater protection in Ireland and Czechoslovakia.
   Venue: GSI, Beggars Bush, Dublin 4. Sept. 3rd at 5.30 p.m.
   Contact - Bob Aldwell 01-609511
   Other speakers will include Donal Daly, GSI and Richard Thorn, Sligo RTC.

2. Landuse planning and groundwater protection.
   Venue: University College Galway, Block R Lecture Room (entrance opposite main door of Cathedral). Sept. 5th at 3 p.m.
   Contact - Mary Kelly 091-24411 Ext. 2213.

Dr. Vrba is a senior member of the staff of Stavebni Geologie (Engineering Geology and Hydrogeology Corporation) in Czechoslovakia. He has travelled and worked in many countries in different parts of the world. He has been President of the IAH Commission on Groundwater Protection since 1980 and worked on behalf of the United Nations on many projects connected with environmental protection.

All are welcome.

Bob Aldwell, President I.A.H. (Irish Branch)

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I.A.H. Technical Meetings

A series of informal discussion meetings (over coffee) on topical groundwater issues are being held on the 1st Tuesday of every month apart from the summer months. The main purpose of the meetings is to share knowledge, experience and views. Each meeting is introduced by one or two speakers for 10-20 minutes and this is followed by a discussion. Four meetings were held so far.

The meetings will recommence after the summer break on Tuesday 2nd October at 5.30pm in the Geological Survey of Ireland. The topic is **"Nitrates and Groundwater".** The speakers will be Richard Thorn on the proposed E.C. Directive on nitrates and Donal Daly on a review of the present situation in Ireland.

For further information on these meetings contact either Kevin Cullen (Tel: 01-697082) or Donal Daly (Tel: 01-609511).

Donal Daly, Geological Survey of Ireland.

NEWS FROM ABROAD

Japan in Hot Water!

The bathhouse or "onsen" has always held a strong place in Japanese Society. Today, owners of Japan's 2189 commercial Spa baths see a threat to their future - geothermal energy stations. They fear that piping geothermal energy into power stations will destroy their sources of hot water and they are willing to use their considerable political clout to avoid this threat.

Work is now underway to re-educate these onsen owners about geothermal energy. Scientists believe that one fifth of Japan's huge energy needs could be provided by this source. At present energy from geothermal resources generates only 0.2% of Japan's electricity because of political pressure against such development. Several pilot plants have been set up, to show how the ancient onsens and modern geothermal plant can work together. These plants extract superheated stream to drive their turbines and then pass the water, still at high temperature, to the onsen.

Another problem is the high cost of building geothermal power stations; at present it is five times the cost of building a nuclear power plant and nuclear energy is also cheaper. But environmental pressure and new developments may change the lead of nuclear energy.

A geothermal plant at Ohruma, in northern Honshu was built 13 years ago at a cost of 3.2 billion yen to supply electricity to a smelter (1£ = 246 yen). The capacity was 10 megawatts i.e. 320,000 yen per installed killowatt. The electricity from the plant now costs around 6 yen per kilowatt hour. To buy this commercially the cost would be 10 yen per kilowatt hour. This plant is an example of what can be done with careful research, it injects water back into the reservoir to prevent land subsidence and provides hot water for the local onsen.

Source: New Scientist, February 17th pp. 58-59.

Terry Hayes

U.S. Registration for Hydrogeologists

The hydrogeology profession is following the general drive for registration. The purpose is to protect the health, safety and welfare of the general public and to strengthen hydrogeology as a science and profession.

The American Institute of Hydrology (A.I.H.) provides a nationwide certification program but qualification for A.I.H. membership is not easy! It involves a rigourous study of credentials followed by a professional examination and a recertification at five year intervals.

In 1989, the institute had 810 members, 16 associate members and 14 corporate members and had organised chapters in over forty states and four countries. The success of the A.I.H. is seen in the huge number of applications it receives for registration. It is hoped that this nationwide body will improve communication between hydrogeologists, increase the standard of the profession and improve the public awareness of hydrogeology.

Source: Moore, J. Jan, 1990. Geotimes pp. 14

Terry Hayes

Britain: Hosepipe Bans and Mains Water Leakages

Two successive dry winters have left groundwater levels in Kent and Sussex at their lowest levels since records began 30 years ago and levels in Yorkshire are low. Hosepipe bans are operating in south and east Devon, most of Kent, Bristol, mid and coastal Sussex and in parts of Yorkshire. The problems are exacerbated by high levels of unaccounted-for water - mainly pipe leakages. The ten recently privatised water companies in England and Wales are losing between 15 and 38 per cent of household water supplies. Source: Observer, 15th July, 1990.

Editor

LOCAL NEWS

Low Summer Water Levels

As a result of a dry spring groundwater levels are low once again this year. In June and July water levels in Geological Survey monitoring boreholes were lower than at the corresponding time in 1989, when levels were unusually low. The recharge in early July decreased the worrying drop in water levels, but if only average rainfall occurs over the next two months, many streams, springs, shallow wells and low yielding wells could be seriously affected.

Some steps can be taken to minimise the consequences of a continuation of dry weather:

1. Monitor the existing position i.e. water levels/flows, output and quality and compare them with those of previous years, particularly 1989. This may allow predictions on the situation in late August and September and may enable planned rather than forced cutbacks.
2. With springs try to reduce overflow (if there are any!) by raising the outlets. Also deepen the springs and lower the pumps. Many engineers fear touching springs. For springs in lowlying areas, this fear is generally groundless. Deepening allows the spring to be used as a well and it increases the area of aquifer that water can be pumped from.
3. Look for emergency supplies - unused springs or boreholes, for instance.
4. Develop new groundwater sources.

With the predicted changes in climate due to the "greenhouse effect", as described by John Sweeney in this Newsletter the development of additional and emergency supplies by local authorities is desirable. Groundwater is the obvious source for these supplies as they are generally less affected by droughts than surface water and are relatively cheap to develop and maintain and complement existing surface sources.

Donal Daly, Geological Survey of Ireland.

GEOLOGICAL SURVEY OF IRELAND
RE-OPENING OF PUBLIC SERVICES

The Geological Survey of Ireland announces that its Public Office, Library and Geological Exhibition have re-opened to the public from 9.15am to 1.00pm and 2.00pm to 4.30pm, Monday to Friday.

The Geological Survey of Ireland, as the national geological information and advisory centre, provides a wide range of geological publications and direct advisory services in applied earth sciences to industry and the public.

The G.S.I. Public Office provides sales and services in the area of geological maps, geological publications and pamphlets, aerial photography and general geological information and advice.

The G.S.I. Library is the principal geological reference library in Ireland with an extensive range of geological books, periodicals and magazines and publications of other Geological Surveys around the world. It is open to the public, on a reference basis, at the above times.

The Survey's principal Exhibition is entitled "Down to Earth" and is a permanent exhibition of Ireland's geology, and mineral resources. It contains extensive rock, fossil and mineral displays in a colourful popular format. It has been widely used by schools as an educational facility and a series of questionnaires are available in the exhibition for school parties and other visitors to use. A second special exhibition on the building stones of Dublin, entitled "Rock by the Liffey" is currently available in the downstairs exhibition area. School groups are invited to make prior booking to the Survey's Public Office (Ms Anne Bredin).

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