IRCWD NEWS

WHO International Reference Centre for Wastes Disposal

Ueberlandstrasse 133, CH-8600 Dubendorf/Switzerland

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No. 16 January 1982

On-Site Sanitation and Groundwater: The Pollution Risk

"Executive Summary of Two IRCWD Reports"

By **C.F. Ward,** University of Southampton, G.B., and **R. Schertenleib,** Manager IRCWD, Dubendorf/Switzerland.

The following article represents an executive summary of two reports to be published in due course by the International Reference Centre for Wastes Disposal (IRCWD). These reports are part of a pre-investigation study conducted in the last year by IRCWD in collaboration with the Technology Advisory Group of UNDP Global Project GLO/78/006 (TAG).

The first report was prepared by W.J. Lewis, IRCWD consultant; S.S.D. Foster, Institute of Geological Sciences in Wallingford; and B. Draser, Ross Institute of Tropical Hygiene in London. It incorporates a review of the literature pertaining to the behaviour (especially survival characteristics) of excreted pathogens and inorganic pollutants (principally nitrates), and the incidence of groundwater pollution from on-site sanitation systems. The second report was prepared by C.F. Ward, University of Southampton and S.S.D. Foster. It describes a methodology for monitoring groundwater quality in relation to on-site sanitation schemes.

Introduction

The development of groundwater resources for potable use has increased substantially over the last two decades. Many countries now rely on groundwater sources to supply a large fraction of their domestic demand for potable water. Still, in many developing countries, a sizeable proportion of the population do not have access to an adequate water supply. Safe excreta facilities are even less common. In 1977, at the Mar Del Plata Conference, UN Member States proposed to make substantial efforts to improve the availability of adequate water supply and safe excreta facilities to all communities. Most governments have endorsed these UN proposals, and are intending to make further substantial investments in water supply and sanitation over the next decade (1981 – 1990) to improve public health and well-being.

To improve adequate water supplies and sanitation facilities for developing countries will necessitate:
- increased use of groundwater,
- major construction programmes utilising on-site sanitation systems (particularly pour flush latrines and ventilated improved pit latrines).

The two solutions to the population's needs may conflict, particularly with certain combinations of hydrogeological conditions. Without an integrated approach involving personnel in the fields of water engineering, hydrogeology, public health and sanitation, and without adequate design and construction, the extensive use of unsewered disposal systems may cause severe groundwater contamination due to pathogenic micro-organisms and biodegradation products of human excreta (such as nitrates). This may expose people to the risk of disease, and thus reduce the anticipated health benefits of providing sanitation facilities. Therefore, in view of the proposed substantial investments in on-site sanitation for both urban and rural areas, it is essential that the relationship between groundwater quality and on-site sanitation is investigated.

To evaluate the risk of groundwater pollution from on-site sanitation systems, it is important to understand the hydrogeological factors which control the direction and rate of groundwater movement and, consequently, the movement of pollutants within the groundwater, and also those factors affecting survival (or elimination and attenuation) of excreted pathogens and undesirable inorganic constituents (such as nitrates). Site conditions vary

considerably and each problem is to some extent site specific, requiring detailed consideration of the local hydrogeology and water supply and sanitation arrangements. However, each site can be described in terms of easily identifiable characteristics, such as depth to water table and nature of the unsaturated zone, and on this basis, the various hydrogeological environments may be classified. A classification should be designed to give an indication of the potential pollution hazard in each hydrogeological environment.

With these aims in mind, the International Reference Centre for Wastes Disposal (IRCWD) has recently commissioned two major studies. The first incorporates a review of the literature pertaining to the behaviour (especially survival characteristics) of micro-organisms and inorganic pollutants (principally nitrates), and the incidence of groundwater pollution from on-site sanitation systems. The second report describes a methodology for monitoring groundwater quality in relation to on-site sanitation schemes. These reports are summarised below.

Report I: "Groundwater pollution from unsewered sanitation: a critical review in relation to site evaluation and risk assessment" (by Lewis, W.J., S.S.D. Foster and B. Drasar)

The aim of this report is to produce a comprehensive review of the literature in order to assess the state of knowledge regarding groundwater pollution from unsewered sanitation systems. Emphasis is placed on microbiological contaminants, particularly faecal bacteria and viruses, and nitrates, which indicate the probable presence of pathogens or themselves represent health hazards, and so are a major cause of concern. From the literature review it has been possible to identify the key factors which affect groundwater pollution from on-site sanitation systems. The report thereby suggests a tentative grouping of naturally occurring soils and rocks within a simplified framework of relative pollution vulnerability (Fig. 1). However, insufficient is known for a fully comprehensive set of guidelines to be drawn up. The majority of the field studies have been confined, in the main, to fine-grained sediments which are of low risk, and the most suitable for on-site sanitation. There is a need to obtain more information on other soil types. In certain

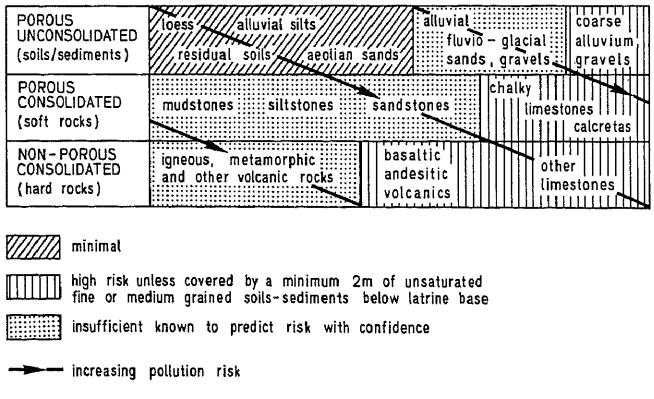


Fig. 1:
Pollution risk relative to various geological environments

hydrogeological environments, it will always be necessary to seek specialist advice and to carry out detailed hydrogeological field studies before implementing any scheme for on-site sanitation. Finally, the report suggests methods of preventing or minimising groundwater pollution.

Reference is made to more than 140 publications which can be grouped into 4 categories: laboratory and field experiments investigating pollution travel, case histories of groundwater pollution and related studies concerning, for example, bacterial survival in soil and water and the treatment capacity of soils used for land disposal of sewage effluent.

It is not always easy to resolve the observations from controlled experiments in the laboratory and field with actual observations of groundwater pollution resulting from use of on-site sanitation systems. For example studies have demonstrated that bacterial and viral survival times in groundwater and soil may exceed 100 days; yet there is little evidence of either moving further from the pollution source than a distance corresponding to that of groundwater flow over a period of 10 days. It is also uncertain how far the findings of studies of other disposal systems, such as septic tanks, are relevant in the present context; the main differences are the concentration of pollutants and the hydraulic loading rate, the effects of which have not yet been adequately studied. Some of the main findings of the literature are presented below:

1. The pollution problem will normally be limited to unconfined aquifers. Where aquifers are confined or semi-confined, on-site sanitation schemes do not present a pollution hazard provided the disposal pits are not excavated through the confining layer, and provided boreholes are properly constructed so that they cannot act as conduits of pollution to the confined aquifer.

2. Of the microbiological constituents of human excreta, it is the bacteria and viruses which, due to their relatively small size, travel furthest in soil and groundwater systems. The major inorganic pollutants (and health risk) resulting from use of on-site sanitation units are nitrates; there is almost inevitably an increase in the nitrate concentration in unconfined aquifers underlying on-site sanitation units.

3. Soil (unconsolidated material) provides a very effective natural treatment system, having, under proper conditions, the ability to remove faecal micro-organisms and to break down or attenuate many chemical compounds. Rocks (consolidated) at shallow depth are almost always fissured, which permits short circuiting of this treatment system.

4. The unsaturated zone (above the water table) affords the most important line of defence against groundwater pollution. The nature of the materials and the thickness of this zone are key factors in determining pollution risk.

5. The reduction of microbiological pollutants largely depends on the regime of groundwater movement which, in turn, is largely controlled by the hydraulic characteristics of the soil. The report describes at length the principles controlling groundwater flow

in the unsaturated zone, and demonstrates the significance of pore size distribution and moisture content.

6. With the continued addition of excreta, the infiltration surface of the latrine pit becomes increasingly clogged. This clogging enhances bacteria and virus removal processes in two ways. Firstly, the "crust" formed at the infiltration surface acts as a very effective filtration medium; a very large proportion of the faecal bacteria, and all the larger helminths and protozoan cysts, are filtered out and eliminated by antagonistic aerobes. Secondly, the crust causes a reduction in the infiltration rate so that the moisture potential in the unsaturated zone below remains relatively high; the vertical hydraulic conductivity is thereby dramatically reduced and the residence time (hence contact time of the effluent and the soil) is increased.

7. Populations of bacteria are so high in human excreta ($>10^9$/g) that significant numbers still percolate through the crust and enter the unsaturated zone along with the smaller viruses.

8. The most important processes eliminating faecal bacteria and viruses in the unsaturated zone are adsorption to mineral surfaces and degradation by other bacteria. However, desorption of micro-organisms may occur with an increase in saturation and flow rates, which may occur for instance if hydraulic loading rates exceed 50 mm/d.

9. Once bacteria and viruses reach the water table, they can be transported over considerable distances in the direction of groundwater flow. Lateral migration in the saturated zone is governed predominantly by groundwater flow velocities which are normally in the order of 1 – 5 m/d where flow is intergranular, although they may be considerably higher, often exceeding 10 m/d or even 100 m/d, in highly permeable strata.

10. The processes responsible for the fixation of bacteria and viruses (primarily adsorption) are, in most cases, much less effective in the saturated zone. Physical dispersion which is primarily responsible for the dilution of pollutants in the saturated zone is difficult to predict.

11. Many field studies indicate that lateral migration of microbial pollutants in the saturated zone is limited to the distance that the groundwater flows in a period of not more than 10 days.

12. The survival characteristics of micro-organisms are obviously of major significance in determining the extent of groundwater pollution. The survival of both bacteria and viruses is greatly influenced by temperature, moisture conditions and water chemistry; warm, dry, acid or saline conditions are least favourable for survival. Inactivation tends to be more rapid near the surface where the natural soil microflora are also active, on the other hand, micro-organisms which penetrate the surface layer of soil have occasionally been found to survive for several months.

13. Nitrates result from the natural decomposition by micro-organisms of organic nitrogenous matter which is present in human excreta principally in the form of urea. Processes operating in the unsaturated zone may remove as much as 90% of the nitrogen from the effluent; however if this is not released from the soil, it will eventually reach the water table in the form of nitrate of ammonium. The only active mechanism of lowering the nitrate content in the saturated zone is by dilution with uncontaminated groundwater.

Attempts have been made, particularly in the earlier classical pollution studies, to relate survival and travel time with distances in order to be able to advocate a "safe" distance between groundwater supply installations and on-site sanitation units. This has lead to a "rule of thumb" separation of 15 m being widely adopted. However, the complexity of the processes operating in the unsaturated and saturated zones, and the heterogeneity of permeability, common in all aquifers, make it difficult to predict any safe separation (for example, faecal pollutants have been detected 920 m from source in one instance).

In view of the complexity of the factors involved, and the potential importance of rather detailed considerations, it would be desirable to treat each settlement or site on individual merit when assessing the faecal pollution risk associated with unsewered sanitation. However, the economics and logistics of low-cost sanitation schemes are such as to preclude the routine use of hydrogeological field investigations and, in practice, a classification of hydrogeological environments is required as the basis for new guidelines.

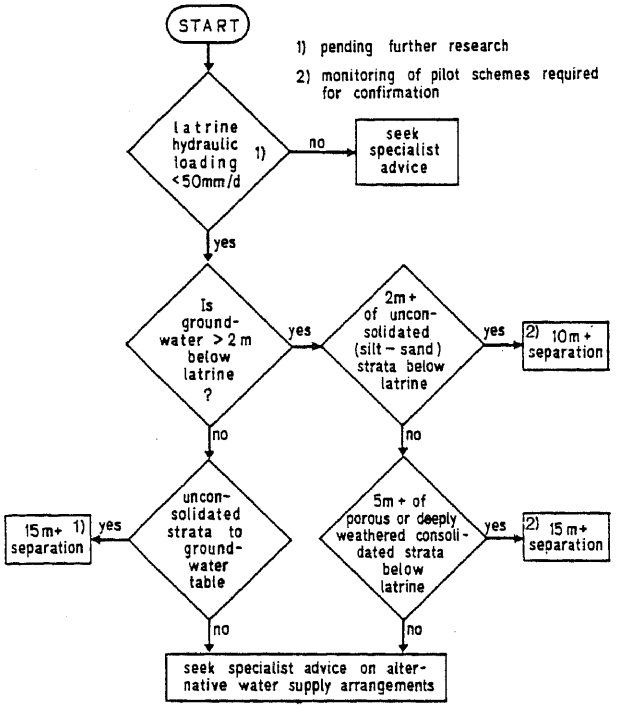


Fig. 2:
Preliminary guideline for safe separation between a water supply borehole and an on-site sanitation unit

A preliminary classification in the form of an algorithm has been drawn up using the main parameters involved (Fig. 2). However, further data are required for its consolidation and extension. Such data could best be collected by detailed field research and/or routine monitoring associated with pilot on-site sanitation schemes.

Report II: "On-site sanitation and groundwater quality: a methodology for monitoring" (by Ward, C.F. and S.S.D. Foster)

The aim of the second report is to enable basic groundwater quality monitoring programmes to be established with the limited manpower and financial resources available in developing countries. The report recommends a methodology for establishing a basic, but meaningful, groundwater quality monitoring programme in areas where on-site excreta and sullage disposal systems are installed or where their feasibility is being considered. Such a monitoring programme may, on the one hand, enable assessment of the potential pollution hazard and, on the other, enable any changes in groundwater quality subsequent to the installation of on-site disposal systems to be adequately monitored. This will enable to collect further data in order to consolidate and extend the preliminary guidelines outlined in the report by Lewis et al.

The report is directed at professionals without previous or detailed knowledge or field experience in hydrogeological, chemical or microbiological aspects of groundwater pollution. The methods recommended for the construction and operation of a monitoring programme, and for the analysis of groundwater samples, utilise, as far as possible, robust and reliable equipment, materials which are normally easily obtainable, and the minimum of specialist knowledge and skills. Field and laboratory analytical techniques are recommended which are generally less demanding in terms of cost, time and skill, whilst still giving tolerably accurate results.

The report is not intended as a field manual although certain sections are explicit and may be useful in the field. It is rather intended to assist in the design and implementation of an observation network and monitoring programme suitable for a specific project area; it is hoped that all who are to be involved with any aspect of monitoring will find the report useful background reading.

In different sections of the report, the following questions are discussed in detail: (a) selection and analysis of a project area; (b) the design of the monitoring network within the project area; (c) the collection, handling and analysis of groundwater samples; (d) the presentation and interpretation of groundwater quality data; and (e) recommendations for follow-up actions.

The main conclusions and recommendations of this report can be summarised as follows:

1. A project area should be selected which is of manageable size, say 2 km^2, so that site conditions can be established in detail. The project area should be representative of the larger region so that results of the monitoring programme can subsequently be extrapolated.

2. The selection of a project area has to be followed by site investigations which should produce detailed information about the local hydrogeology and existing and proposed sanitation, drainage and water supply facilities. It is important to establish the background groundwater quality prior to the installation of on-site sanitation and upgradient of the project area.

3. The observation network should incorporate at least one rainfall station and a minimum of 8 groundwater level observation wells or boreholes.

4. Simple observation boreholes employing slotted casing are recommended. These can usually be constructed with locally available resources.

5. Sampling, installations and methods should aim at producing groundwater samples that are truly representative of the water in the aquifer. Depth specific samplers are recommended since it is useful to establish which part of the aquifer contributes the sample. It is particularly important to sample from the vicinity of the water table, i.e. at the top of the saturated zone.

6. Samples can be collected from existing pumped sources, naturally flowing springs and purpose-built, depth specific sampling installations. Various precautions are necessary in each case to ensure the representativeness of each sample.

7. Sampling sites should be concentrated around major groundwater sources, and generally located between sanitation and water supply units. Each type of disposal unit may pose a different pollution hazard and the monitoring network should enable close study of latrine performance. The design of the sampling network will depend, to a large extent, on the density of water supply and on-site sanitation installations.

8. Groundwater samples should be collected for analysis, and the complimentary observations of rainfall and groundwater levels made initially at weekly intervals. Once a pattern is established, it may be acceptable to reduce these frequencies.

9. The monitoring period should normally continue for at least 3 years and should ideally commence 1 year prior to the installation of on-site sanitation.

10. Samples should be analysed for selected indicators of faecal pollution. It is recommended that routine microbiological analysis should be limited to the enumeration of faecal coliforms and faecal streptococci; chemical analysis should normally be restricted to the determination of chloride, nitrate and, in certain cases, nitrite, ammonium and iron. In addition, the physical characteristics of temperature and electric conductivity should be recorded in the field.

11. If at all possible, analyses should be carried out immediately in the field using field kits and portable instruments, otherwise care must be taken to preserve samples to avoid any quality deterioration prior to analysis in the laboratory.

12. Standard laboratory methods and materials should be used so that analytical results are truly comparable. Certain methods and equipment are recommended as most suitable in the present context.

13. The data from the observation and sampling programme should be collated and interpreted as it is gathered so that the monitoring programme can be continually updated and any anomalies immediately checked. The use of graphs and maps which are visually clear is recommended.

14. The report comments on the significance and interpretation of results in order to indicate the reasons behind the requirements of a monitoring network.

15. Finally, guidelines are given for appropriate follow-up action in each of 3 cases: (1) where there is no change in groundwater quality; (2) where sampling points, but not water supplies, are contaminated and (3) where the groundwater sources themselves are polluted.

Concluding remarks

Before any comprehensive guidelines can be drawn up for the safe separation of on-site sanitation systems and groundwater supply installations, it is necessary to derive a classificatory system for hydrogeological environments in relation to pollution risk. With the present incomplete state of knowledge regarding the survival and movement of pollutants (and the pathogenic bacteria and viruses in particular) in soil and groundwater systems this is not yet possible.

Particular areas requiring further research are: effects of hydraulic loading, behaviour of pollutants in less favourable hydrogeological environments and viral contamination of groundwaters. More detailed field studies are required if the discrepancies between experimental and field data are to be resolved. Groundwater quality monitoring programmes should be established wherever on-site sanitation and water supply wells and boreholes are to exist side by side.

Further consideration also needs to be given to the implementation strategy of sanitation and water supply schemes. A piecemeal approach to the provision of sanitation will make groundwater monitoring and the protection of groundwater supplies all the more difficult.

In conclusion, more sophisticated monitoring programmes and detailed field studies are necessary to extend the present state of knowledge regarding groundwater pollution from on-site sanitation systems. The International Reference Centre for Wastes Disposal is at present preparing a project proposal report embodying recommendations for such field studies.

Effective monitoring programmes and detailed field studies inevitably involve some expense. This expenditure is necessary if the anticipated health benefits of on-site sanitation and potable water supplies are to be realised.

Entomological Studies of On-Site Sanitation Systems in Botswana and Tanzania – A Summary of Findings

Insect breeding in non-water-sealed latrines is a well-known and serious problem. The main medically important insects involved are *Culex quinquefasciatus*, the vector of Bancroftian filariasis and some arboviruses in certain parts of the world, and a major nuisance mosquito, and blowflies (mostly *Chrysomia putoria* and *C. megacephala*) which can act as mechanical vectors of faecal contamination.

The use of vent pipes on pit latrines, now gaining wide acceptance, is thought to reduce fly breeding. A study funded by the International Reference Centre for Wastes Disposal (IRCWD) was conducted in Gaborone (Botswana) and Dar-es-Salaam (Tanzania) by **Chris Curtis** and **Peter Hawkins** (Ross Institute of Tropical Hygiene in London), in order to assess the effectiveness of ventilation in reducing insect breeding of all kinds. In addition, some traditional, unventilated pits were included in the study. The main findings of this study can be summarised as follows:

- insect larvae were collected from pits using a dipper, whilst adults entering or emerging were caught using appropriately placed traps made from old paint tins and insect proof gauze. The insects identified were mostly *Culex quinquefasciatus* with a few *C. antennatus* isolated from one pit, and *Chrysomia putoria* mixed with lesser numbers of *Hermetia spp., Senaspis haemorrhoa* and *Musca domestica. Telmatoscopus spp.* were found in quite large numbers but were ignored, being medically unimportant,

- there was no significant difference in the frequency of occurrence of fly breeding in wet (with a free liquid surface) and dry (either well-drained or scum-covered) pits, contrary to some popular views. Mosquito breeding occurred exclusively in wet pits, as would be expected, the larvae requiring water to swim in and a free liquid surface for the breathing syphon,

- in ventilated pits, both mosquito and fly larvae were much more common when the vent pipe was not covered by insect proof gauze (91%) than when it was (33%). This simple aspect of construction had been neglected on many of the ventilated improved pit latrines and, in many cases, where steel gauze was used, it had corroded away within a year. The use of PVC coated glass fibre gauze would be better,

- gravid female insects seeking heavily polluted waters to lay their eggs are attracted by the odours issuing from the vent pipes of ventilated pits. When traps were set to catch entering insects, 100% of flies and 74% of mosquitoes preferred the vent pipe to the drop hole. When the choice between vent pipes (situated 1 m apart) from the used and unused pits of a twin pit latrine was presented, 100% of flies and 77% of mosquitoes chose the used pit,

- when breeding does take place in a ventilated pit, flies, and to a lesser extent, mosquitoes exhibit phototropism in their choice of exit (i.e. vent pipe or drop hole). 94% of flies chose to leave via the vent pipe when the latrine door was closed, but only 52% when it was open, increasing the light intensity at the drop hole. When a screen was substituted for a trap on the vent pipe, the increase in light intensity increased the proportion choosing the vent pipe to 62% (with open doors),

- for mosquitoes, the phototropism was less marked; 83% choosing the vent pipe when the door was closed, as opposed to 60% when it was open. However, in heavily infested pits (daily production in excess of 1000 mosquitoes), only 64% were caught in a vent pipe trap when latrine doors were closed, and this dropped to 12% when the trap was replaced by a screen on the vent pipe. These results suggest that mosquitoes may be more persistent than flies in seeking an alternative exit when prevented by a screen or discouraged by large numbers already present in the vent pipe,

- overall the study shows that a screened vent pipe very substantially reduces insect breeding and emergence in pit latrines, and that this effect is more marked for flies than for mosquitoes. The major determinants of this behaviour appear to be odour emission from the vent pipe as an attractant for gravid females, and the phototropic behaviour of emergent adults in the pit trying to get out,

- the small number (but, from a vector control perspective, highly significant) of pits heavily infested with mosquitoes may require additional measures such as the permanent use of drop hole traps. The ecology of such pits (which appear to give consistently high production year after year) needs further investigation. Mass trials of drop hole traps on unventilated pits are already under way and will be reported in late 1981.

The full report of this study will appear in the *Transactions of the Royal Society of Tropical Medicine and Hygiene* (Vol. 76, No. 1) in February, 1982. Persons requiring copies of this report, or further information, should write to the International Reference Centre for Wastes Disposal (IRCWD).

«IRCWD NEWS»

The regular reader of IRCWD News has probably noticed its rather irregular appearance in the last few years. This is due to organisational and conceptual changes within the International Reference Centre for Wastes Disposal (IRCWD). It is proposed that the IRCWD News will appear again biannually, and will be used mainly to inform people interested in the field of low-cost sanitation and waste disposal about the ongoing work at IRCWD. The following is a brief summary of the main ideas behind the new IRCWD concept.

A new concept for IRCWD

The "International Reference Centre for Wastes Disposal" (IRCWD) was established in 1968, based on a suggestion by the "Scientific Group on the Treatment and Disposal of Wastes" of the World Health Organization (WHO). The Centre is located at the "Swiss Federal Institute for Water Resources and Water Pollution Control" (EAWAG), and is based on a contractual technical service agreement between the WHO and the Swiss federal authorities.

Currently the staff of IRCWD consists of four people: a manager, a project engineer, a translator/documentation supervisor, and a secretary. In order to conduct specific research projects, IRCWD has been employing outside consultants with expertise in the respective field of study.

The IRCWD is subordinate to the Director of the EAWAG, although it is financially autonomous. Most of the funds are provided by the Swiss Government, while the remainder come from WHO. However, possibilities do exist to obtain funds from other multilateral and/or bilateral development agencies for specific research projects.

Since the establishment of IRCWD, its main activities have been in the following areas:

- a documentation centre for solid wastes offering processed documents (abstracts) selected from 30 different European and American periodicals and publications. A thesaurus composed of 484 scientific and technical terms in the field of solid waste management serves as a basic reference for information storage and retrieval,
- an Annotated Bibliography on Compost, Compost Quality and Composting (1971–1977) was published. This bibliography contains 415 annotated references on compost from the solid waste documentation,
- Methods of Analysis of Sewage Sludge, Solid Wastes and Compost was published in 1978,
- an Information Bulletin (IRCWD News) containing a leading article, selected abstracts from the documentation centre, and news from WHO Headquarters was published periodically.

In addition, IRCWD organised study trips for WHO fellows from all over the world to the EAWAG's highly sophisticated laboratories.

However, in the last few years it has become clear that the need for a reference centre based on the old concept had decreased considerably. On the other hand, it is obvious that there is a widespread lack of information and literature on solid and liquid waste disposal technologies appropriate to the economic and socio-cultural conditions prevailing in developing countries. This is one of the reasons why most of the rural population in developing countries, and a sizeable fraction of the urban population lack access to safe water supplies and excreta disposal facilities.

Thus, EAWAG has decided, in agreement with the World Health Organization, to concentrate the future activity of IRCWD on the problems of liquid and solid waste disposal in developing countries. Through IRCWD, the comprehensive scientific and technical knowledge within EAWAG is available to improve the prevailing situation in the Third World, not only with regard to hygienic aspects but also in terms of the long-term effects of different technologies on the environment. Therefore, IRCWD will concentrate in the future on research, consulting and training in the fields of solid and liquid waste disposal, and in water protection in developing countries.

Research activities

In general, the research projects conducted or funded by IRCWD are directed towards finding:
- technologies most appropriate to given economic and socio-cultural conditions,
- the scientific bases of low-cost technologies, and the simplest ways of improving them and,
- the effects of low-cost technologies on surface and groundwater quality.

IRCWD's policy is to carry out, whenever possible, this research in developing countries and in close collaboration with local institutes and organisations as well as with European agencies experienced in tropical hygiene.

Current research projects of IRCWD are summarised in another section of this Newsletter.

Consulting activities

IRCWD acts as a consultant to multilateral and bilateral aid agencies concerned with the disposal and treatment of liquid and solid waste in developing countries. IRCWD also directly assists governments of small Third World countries in the elaboration of national water protection policies.

Consulting activities in 1980 included:
- a consulting project on behalf of WHO to formulate waste disposal measures in Conakry (Republic of Guinea) hospitals,
- participation in project studies concerned with the environmental sanitation problems in Dar-es-Salaam, Tanzania,
- providing information to developing countries with regard to appropriate water supply and wastewater disposal technologies (partly in collaboration with the Swiss Centre for Appropriate Technology, SKAT).

Educational activities

IRCWD participates primarily in the training of Swiss personnel for developing countries (within the scope of the post-graduate programme for developing countries at the Swiss Federal Institutes of Technology). It also assists WHO fellows from developing countries in completing their practical training at the EAWAG (Institute for Water Resources and Water Pollution Control). In future, however, the training of experts from developing countries will gradually be transferred to Third World countries, where IRCWD is planning to participate in the creation of regional training centres for teaching professionals.

IRCWD Projects

- **Risk of groundwater pollution by on-site sanitation**

Since November 1980, IRCWD has been involved in a study examining the relationship between groundwater pollution and on-site sanitation in different soils and hydrogeological conditions. IRCWD consultants have already conducted a detailed analysis and review of the existing literature on the subject. So far, two documents have been prepared, and will shortly be published by IRCWD, namely:

(a) **"Groundwater pollution from unsewered sanitation: a critical review in relation to site evaluation and risk assessment"** (by Lewis, W.J., S.S.D. Foster and B. Drasar)

(b) **"On-site sanitation and groundwater quality: a methodology for monitoring"** (by Ward, C.F. and S.S.D. Foster)

An executive summary of the two documents appears as the leading article in this Newsletter.

The literature review showed very clearly that insufficient information is currently available on the relationship between groundwater quality and on-site sanitation. Hence, applied investigations under different hydrogeological conditions are required to fill the extensive data gap, and to promote sounder engineering guidelines. At present, IRCWD is trying to identify field sites which are suitable from a hydrogeological point of view, and which would enable funding to be obtained from donor agencies.

- **Studies on appropriate devices for emptying on-site excreta disposal systems in developing countries**

A considerable amount of work has been carried out recently on improving existing designs, and developing technically sound design criteria for pit latrines. However, very little consideration has been given so far to the problem of pit emptying.

Pit latrines are usually designed in such a way that when they are full, the superstructure can be moved to a new site, or a second pit used while the contents of the first are left to decompose into harmless and inoffensive material.

In some cases, however, it may be necessary to empty a pit containing fresh, hence pathogen-laden excreta. This is likely to occur if the householder cannot afford to dismantle the superstructure and re-erect it elsewhere, if only one single pit is available due to financial limitations, or if there is insufficient space on the plot to accommodate a second pit. These constraints are common in low-income areas.

In many Third World countries, pit emptying services have been in operation for many years. However, most of these services have proved inefficient and unsatisfactory due to organisational as well as technical reasons. Apparently, there is a lack of appropriate emptying devices which meet the special requirements of developing countries. Most of these devices consist of vacuum tankers developed in industrialised countries for emptying septic tanks and flushing sewers. Hence, they are particularly suited for removing water and very thin sludges, but not slurries containing solid material commonly found in pit latrines. In addition, they are often very sophisticated and hence cannot be properly maintained in poor countries.

In the spring of 1981, IRCWD conducted field studies on pit latrine emptying services and pit latrine contents in Dar-es-Salaam (Tanzania) and Gaborone (Botswana), in order to evaluate the technical problems regarding these excreta disposal systems. In the autumn of 1981, an IRCWD consultant undertook an extensive journey through the Far East to investigate pit emptying systems in Japan, China, Republic of Korea and Thailand. These countries are known to have very efficient systems.

- **Entomological studies of on-site sanitation systems**

Some on-site sanitation systems, especially pit latrines and various other modified models, have the drawback of creating perennial breeding sites for certain medically important insects. The most important of these are: (a) the mosquito *Culex quinquefasciatus,* which breeds in polluted water, is not a vector of human malaria but the vector of Bancroftian filariasis in some regions, and the major nuisance mosquito in urban areas, and (b) the blowflies, especially *Chrysomya putoria* and *C. megacephala,* which breed in faecal liquids and moist solids and may carry faecal material to food or on to hands and faces.

Some of the designs recently promoted for improved on-site sanitation incorporate a vent pipe in order to exhaust foul air and control insect breeding. An earlier study in Zimbabwe showed that pit latrines with vent pipes produced far lesser numbers of flies than comparable latrines without vent pipes. This was presumably because the young flies emerging from the pits were attracted up the vent pipe by light and trapped by the insect screen at the top. In addition, the screen prevented entry of egg laying females apparently attracted to the vent pipe.

In the spring of 1981, a study was undertaken to investigate further the production of flies and mosquitoes by on-site sanitation systems with regard to vent pipes and other design features. Dar-es-Salaam (Tanzania) and Gaborone (Botwana) were selected as the study sites because these cities provide a wide range of groundwater conditions, and because many traditional and improved latrines of several designs have been in use. They are also the sites of major on-site sanitation improvement programmes.

The main findings of this study are summarised in a separate article of this Newsletter.

- **Review of socio-cultural aspects of low-cost sanitation in developing countries**

In recent years, a considerable amount of information on low-cost sanitation has been published and reviewed. However, the main emphasis in these publications was mostly placed on technical aspects of the problems. Little information is available on the socio-cultural aspects involved in introducing these low-cost sanitation technologies.

Therefore, IRCWD has just started a study in order to review the existing experience of social, cultural and institutional aspects of environmental sanitation programmes in developing countries. The issues to be addressed include:

- factors which inhibit usage of latrines,
- methods of extension, payment, management and maintenance,
- the history, experience and institutional design of environmental sanitation programmes in developing countries.

We would appreciate if any reader with documentary evidence or field experience in any of these issues regarding a developing country, could write to IRCWD. At the conclusion of the work, a paper summarising the main findings of the review will be produced. Any reader interested in receiving this paper should indicate this on any submitted material.

- **State-of-the-art review on the integrated use of anaerobic processes in developing countries**

In recent year, developing countries are showing a considerable interest in the use of anaerobic digestion. This interest has arisen due to a number of factors. Firstly, the rapidly increasing price of fossil fuels has forced these countries to look closely at renewable energy sources. Since anaerobic processes generate methane, they are being considered as a future producer of energy. Secondly, with increased interest in public health and low-cost sanitation, anaerobic treatment is being considered as a viable low energy, low capital form of treatment with a considerable potential for pathogen destruction. Also, due to recent developments in engineering design, anaerobic processes are becoming more relevant to problems encountered with industrial waste treatment. Finally, for those people concerned with the stability of

agricultural ecosystems, and nutrient recycling, anaerobic digestion offers a means whereby agricultural residues can be recycled to the land without a significant loss in their nutrient value.

Hence, it is apparent that anaerobic processes have the potential to contribute significantly in alleviating a number of serious problems in developing countries. However, in the past, the normal approach has been to consider each of these factors separately, which has led to a fragmentation of knowledge, and often to the elimination of anaerobic treatment as an alternative. If a more integrated approach was used to solve some of the problems mentioned above, then anaerobic digestion could become more viable than initially supposed.

Due to this renewed interest in anaerobic processes in recent years in both developed and developing countries, considerable progress has been made in both the theoretical aspects, and in practical engineering designs. It seems of paramount importance to disseminate this information in order to use anaerobic processes to their fullest potential in developing countries.

IRCWD has recently initiated a state-of-the-art review on the integrated use of anaerobic processes in developing countries. This review is being partly funded by UNDP through its Global Project on "Research and Development in Integrated Resource Recovery", and will be completed by July 1982.

The objectives of this review are the following:
- consolidate the latest formal and informal literature on the use of anaerobic processes for sanitation/waste treatment, energy production and nutrient recycling in developing countries with respect to both technical and socio-cultural aspects,
- develop scientific design criteria for anaerobic processes based on the various required objectives, i.e. sanitation, energy, nutrient recycling,
- identify key problems which would need further research,
- publish the above information in a form suitable for widespread dissemination to interested parties.

Information pertinent to these objectives is being sought, especially unpublished reports, field data, and literature not normally accessible through conventional means. Comments, criticisms and suggestions are also being sought with respect to the scope of this project. Information and comments should be sent to: Dr D. Stuckey, IRCWD.

Any reader interested in receiving the final review should indicate this on any submitted material, or write to:
International Reference Centre for Wastes Disposal (IRCWD), Ueberlandstrasse 133, CH-8600 Dubendorf/ Switzerland.

New Publications

New WHO Publications

Drinking-water and sanitation, 1981–1990. A way to health, Geneva, World Health Organization, 1981.
ISBN 92 4 156068 1. 56 pages. Price: Sw.fr. 9.–.
French edition in preparation.

This publication is a contribution by WHO to the International Drinking Water Supply and Sanitation Decade, 1981–1990. The aim of the Decade is to make available to all people by 1990 a supply of safe drinking-water and adequate sanitary facilities. The Decade is seen by WHO as representing an essential first stage in the global programme of health for all by the year 2000, and this publication provides a blueprint for that stage.

At present, approximately three out of five persons in developing countries do not have access to safe drinking-water, and only about one in four has any kind of sanitary facility. Thus, the task of correcting these deficiencies by 1990 is formidable.

It has been stated that the Decade cannot succeed if the same technology and the same management approach are applied as in the past. WHO has therefore adopted a "Decade approach", which can be summarised as follows: the Decade must contribute to implementing primary health care; water supply and sanitation development should be complementary and they should be jointly associated with other health development; policies and programmes should be focused on rural and urban underserved populations; full coverage should be achieved through reproducible, self-reliant and self-sustaining programmes; the people for whom the services are intended should be associated with all stages of programme and project development; the Decade should be a matter of collaboration between all contributing sectors.

The introductory chapter of the book sets out the Decade targets and outlines the Decade approach. In the next chapter, various aspects of community water supply and sanitation in the Decade are examined, including WHO's policy and the relationship between primary health care and the Decade. This chapter also discusses in detail the essential elements of the Decade approach.

A framework for national action is then put forward, including formal plans and planning processes; community participation in the planning process; the organisation of strategy seminars and national workshops; and the importance of communications and education. Decade programmes are subdivided into coverage programmes and support programmes, and the need to strike a balance between the two is emphasised. Coverage programmes and support programmes are then dealt with in detail, and a final section discusses the role of health agencies in the Decade.

Waste Stabilization Ponds — Design and Operation, (Report of a Seminar held in Lahore, Islamic Republic of Pakistan, 29 December 1979 — 5 January 1980), **WHO/EMRO Technical Publication** No. 3, 341 pages. Price: US $ 5.—. Specially favourable terms are available for orders from developing countries. Available through WHO Regional Office for the Eastern Mediterranean, P.O. Box 1517, Alexandria, Egypt.

Human and industrial wastewaters may well rate as the greatest single source of human disease and misery. If not hygienically treated they are the principal vehicle for the transmission and spread of a wide range of communicable diseases. Some of these are the main cause of sickness and death in societies particularly those where poverty and malnutrition are ubiquitous. The collection, transportation, treatment and disposal of liquid wastes are therefore of utmost importance for the protection of health of any community.

In most countries in the Eastern Mediterranean Region of WHO, as indeed in other Regions, constraints of manpower and funds make it hardly possible to adopt conventional methods of wastewater treatment. It is imperative therefore that low-cost and appropriate technologies in this field be developed and their use encouraged. Stabilization ponds constitute one of such methods which are not only economical but also suitable for weather and climatic conditions prevailing in the countries. It was in response to this urgent need that WHO/EMRO took steps to organise the Seminar on this subject. An attempt was made to cover fully all aspects of the stabilization pond technology.

This publication has been divided into five parts. While Part I gives the summary report of the meeting, Part II provides the summary of papers and subsequent discussions on them. Since the subject is on a specialised technical topic, some selected papers which specifically cover design, construction and operational aspects have been given in Part III. The reports by the participants from different countries form Part IV of this book. All Annexes are contained in Part V.

It is hoped that this publication will serve the purpose of disseminating information to persons professionally concerned with the field of wastewater disposal and treatment.

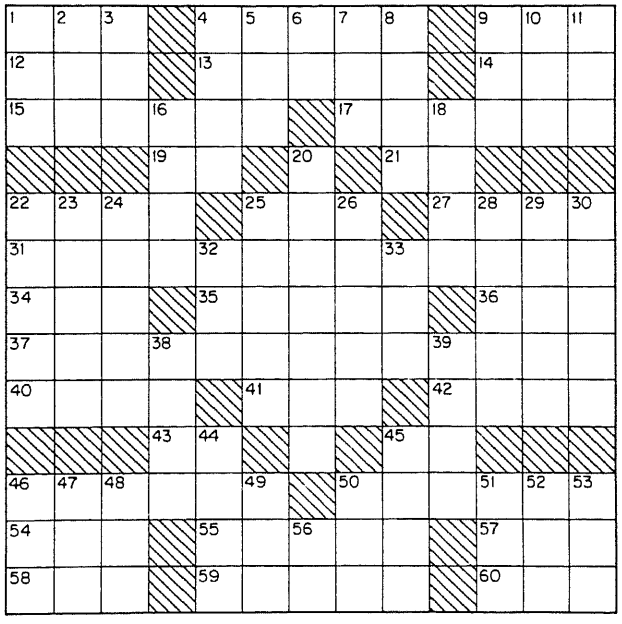
Community Participation in Water and Sanitation; Concepts, Strategies and Methods by **Dr Alastair White,** WHO International Reference Centre for Community Water Supply and Sanitation, The Hague, The Netherlands, Technical Paper No. 17, June 1981, 180 pages. Price: US $ 15.00 per individual copy. Payable in advance by cheque or international money order made out to IRC Community Water Supply and Sanitation, P.O. Box 5500, 2280 HM Rijswijk, The Netherlands. Please also quote bank account No. ABN 514218428. Non-commercial agencies in the developing world may apply for a free copy.

Dr White examines the factors of a socio-cultural and political nature which must be taken into account by an agency or government which is considering the use of community participation methods in the planning and implementation of community water supply and sanitation schemes in developing countries.
It draws on the literature concerning community participation and education in water supply, summarised in Christine van Wijk-Sijbesma's Community Participation and Education in Community Water Supply and Sanitation Programmes, A Literature Review (IRC Technical Paper 12, revised edition 1981) and on the experience of community participation in other fields, especially that of health.
Dr White includes the varying grades of experiences of both socialist and mixed economies and discusses in an objective, analytical way the complex concept of community participation which more often than not is misunderstood or oversimplified. He pays particular attention to differences of interests, especially within villages, which are often overlooked in the literature. A chapter on community health education draws from the general findings of social psychology to recommend an approach emphasising collective commitment to change.
Options for community participation, the circumstances appropriate to promote them, and possible difficulties to be encountered, are laid out clearly in this scholarly, yet practical monograph.

Small Community Water Supplies, handbook published by the **WHO International Reference Centre for Community Water Supply and Sanitation, The Hague, The Netherlands, Technical Paper** No. 18, August 1981, 378 pages, 244 figures, 24 tables. Non-commercial organisations and individuals with an active involvement in rural water supply or sanitation in developing countries may apply for a free copy of the publication. Others will be charged U.S. $ 20.00 per individual copy (inclusive handling and mailing charges). Bulk orders (10 copies or more) may be placed at special prices which are available upon request. Orders can only be handled after receipt of bank cheque or money order made payable to IRC Water and Sanitation Centre, Rijswijk (The Hague), The Netherlands, or after credit confirmation of bank transfer to ABN Bank, Rijswijk (The Netherlands), account No. 514218428, quoting "Technical Paper No. 18".

The handbook has been designed to provide a broad introduction into the technology of small community water supplies. It provides information and guidance that should be most readily used by those having some technical background in civil engineering, public health or irrigation, but with no formal training or experience in water supply. It should serve engineers and public health inspectors who are called upon to assume responsibility for the design and/or maintenance of small water supply systems. This group also includes provincial and town engineers who have responsibility for water supply and sanitation, amongst many other tasks. The book, therefore, has not been written as a textbook for engineering students nor as a design manual addressed to technicians. Some theoretical explanations have been included but such material has been kept to a minimum. For in-depth information reference is made to monographs and textbooks.

Pollution Puzzle



Across:

1. Small antelope of Tibet
4. Excreta receptacle
9. Spanish abb. for Mrs
12. Essential to life
13. To follow
14. Main vein in a leaf
15. Mixture of solids and liquid
17. Change into gas
19. Hemoglobin (symbol)
21. Low tension (abb.)
22. Not false
25. Wireless code-signal of distress
27. Opposite of sciences (pl.)
31. Stabilisation pond
34. British Standard Beam (abb.)
35. To remove pollutants
36. French pronoun
37. Effluent absorption area
40. Famous European volcano
41. Not to scale (abb.)
42. Determined quantity
43. Pronoun
45. Wave length (abb.)
46. Bait fish
50. Excremental
54. In favour of
55. Conduit for liquid waste
57. Lyric poem
58. Not old
59. Heavy gradient
60. Grief

Down:

1. Stack effluent
2. Combustible substance
3. Group of islands in the Netherlands East Indies
4. Necessary in most phrases
5. Some
6. Pronoun
7. Large worm
8. Fresh-water duck
9. Hindu title of address
10. Hilly region of Morocco
11. To pay for
16. The South American ostrich
18. Male deer
20. Sometimes considered as pests (pl.)
22. In geology, a horizontal stratum
23. Transplant
24. As opposed to rural
25. Small European bird
26. Combustion residues (pl.)
28. Famous Shakespearean hero
29. Utensils (pl.)
30. Sarcastic
32. Thyrotrophic hormone (abb.)
33. Automatic transmission fluid (abb.)
38. Abel's brother
39. Inactive
44. Throw
45. Distort
46. Most probable number (abb.)
47. Anger
48. At present
49. Saturated with water
50. Charge, payment
51. Familar farm animal
52. Fuss
53. Shelter
56. Pronoun

CIRCULAR

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In the tear-off section on the back of this page, we are requesting information which will help us in our evaluation. Kindly fill in the requested information and return the form to us by 31 March 1982.

If no reply is received from you by that date, we will assume that you do not wish to continue receiving "IRCWD News".

Thank you in advance for your help.

S. Peter, Editor
"IRCWD News"
Swiss Federal Institute for Water Resources and Water
Pollution Control (EAWAG)
Ueberlandstrasse 133, CH-8600 Dubendorf, Switzerland

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