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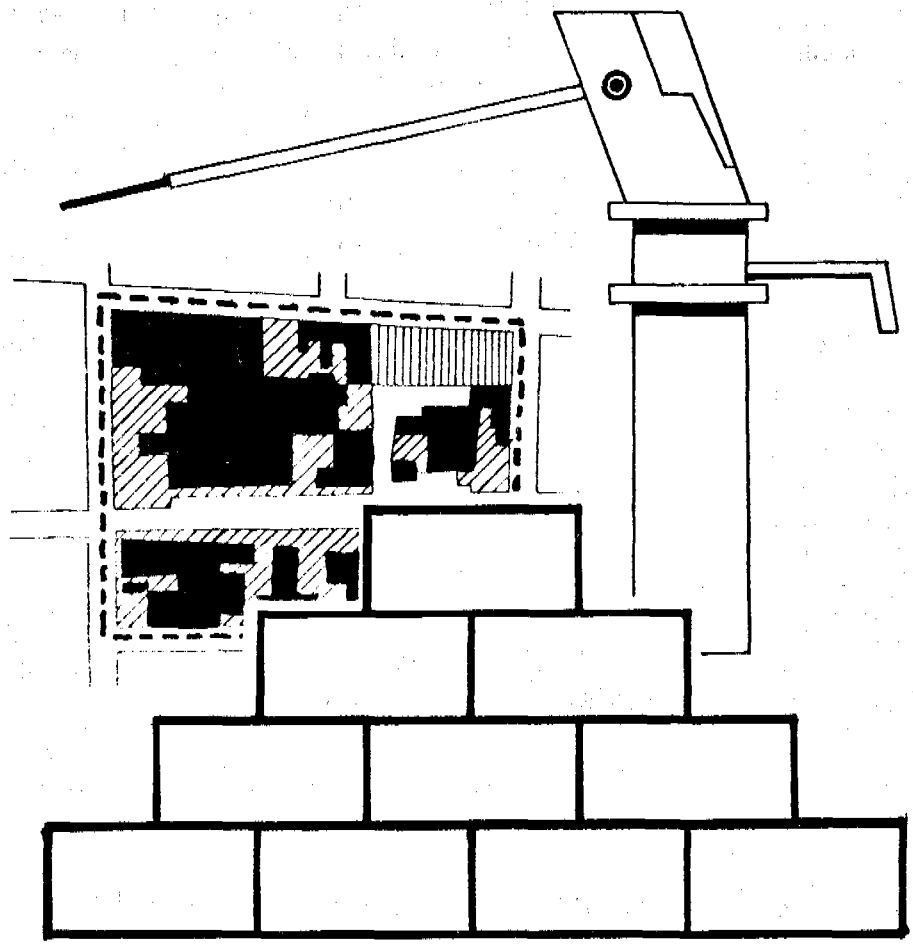
Water, Engineering and Development Centre

Loughborough University of Technology, Leicestershire, England

THE PROCEEDINGS OF THE 14TH WEDC CONFERENCE

WATER AND URBAN SERVICES IN ASIA AND THE PACIFIC



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14th WEDC Conference

Water and urban services In Asia and the Pacific

Kuala Lumpur 1988

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14th WEDC Conference

Water and urban services in Asia and the Pacific

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Participants

Name	Address
Assoc Professor Abdul Aziz Hassan	Deputy Vice Chancellor (Academic), Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
Abdul Jalil Mohd Nor	Bahagian Kejuruteraan Awam, Politeknik Ungku Omar, Jalan Diary, Ipoh, Perak, Malaysia
Abdul Rahim Shamsudin	Jabatan Bekalan Air Negeri Sembilan, Tingkat Bawah, Blok B, Wisma Negeri, Seremban, Negeri Sembilan, Malaysia
Abdul Rahman Idris	PP 193 Pinggir Pelangi, Muadzam Shah, 26700 Pahang, Malaysia
Abd Shukor Omar	Civil Engineering Faculty, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
G V Abhyanka	TATA Consulting Engineers, 34 Sant Tukaram Road, Carnac, Bombay 400 009, India
Abu Bakar Fadhil	Civil Engineering Faculty, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
Abu Bakar Hassan	Jabatan Kesihatan, Dewan Bandaraya, Jalan Tun Razak, Kuala Lumpur, Malaysia
Ahmad Saidin	Water Works Branch, PWD HQ Jalan Mahameru, 50582 Kuala Lumpur, Malaysia
Ahmad Tajuddin Kechik	Jabatan Seni Bina, Fakulti Alam Bina, Universiti Tecknologi Malaysia, 80990 Skudai, Johor, Malaysia
Ahmad Thani Alias	Pejabat Pembersihan Pembetungan, Jalan Pantai Dalam, Kuala Lumpur, Malaysia
Ahmad Zaidon	Civil Engineering Faculty, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
Dr Mohamed Morocco Akallal	PO Box 18418, Salalah, Oman
Azzan Ahmed Alshanfari	PO Box 18275, Salalah, Oman
Amran Hamzah	Jabatan Perancang Bandar & Wilayah, Fakulti Alam Bina, Universiti Teknologi Malaysia, Skudai, Karung Berkunci 791, 80990 Johor Bharu, Malaysia
Dr Anhar Suki	Department of Environmental Sciences, Universiti Pertanian Malaysia, 43400 Serdang, Selangor Darul Ehsan, Malaysia
Anuar Mootajan	JKR Johor Tenggara, 81900 Kota Tinggi, Johor, Malaysia

Ariff Ibrahim	Jabatan Bekalan Air Selangor, Daerah Sepang, Bandar Baru Salak Tinggi, 43900 Sepang, Selangor Darul Ehsan, Malaysia
Dr Asiah Husin	Fakulti Sains, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
Azhar Ahmad	Civil Engineering Faculty, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
Azlan Abdul Aziz	Department of Civil & Environmental Engineering UPM, 43400 UPM Serdang, Malaysia
Bai Yongjiu	No 2 Taiyuan Street, Shenyang Urban & Rural Construction Department, Liaoning, China
K Narendra Baral	c/o Sata (Nepal), PB 113, Kathmandu, Nepal
Dr Morag Bell	Department of Geography, Loughborough University of Technology, Leicestershire LE11 3TU, England
Professor N Blakebrough	3 Jalan 1217, 46200 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Dr Robert M Bradley	Engineering Science, PO Box 84, Mount Lavinia, Sri Lanka
Che Mohd Hashim Che Daud	KESEDAR Bandar Baru Gua Musang, 18300 Gua Musang, Kelantan, Malaysia
Professor Che Xianxin	No 2 Taiyuan Street, Shenyang Urban & Rural Construction Department, Liaoning, China
Cheong Pui Keng	c/o KESORA, 677 Jalan Petrie, 80906 Johor Bharu, Johor, Malaysia
Chin Soon Loi	PO Box 211, 91108 Lahad Datu, Sabah, Malaysia
Manus Coffey	Director, Manus Coffey Associates Limited Newtownmountkennedy, County Wicklow, Ireland
Dr Andrew Cotton	WEDC, Loughborough University of Technology, Loughborough, Leicestershire LE11 3TU, England
Daruis Abdullah	PKNS-Praton Haus Bhd, Lot 12, Jalan Usaha, Kawasan Perusahaan, 40000 Shah Alam, Selangor Darul Ehsan, Malaysia
B A Dayananda	302 Galle Road, Colombo-4, Sri Lanka
Dhanagunan G R	23 Jalan SS 17/2G, Subang Jaya, Selangor Darul Ehsan, Malaysia
Dzulkarnain Khalid	Civil Engineering Faculty, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
Engku Mohd Suhaimi W Basir	Bahagian System Perumahan dan Struktur, Perbadanan Kemajuan Negeri Selangor, Persiaran Barat off Jalan Barat, 46505 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Fadil Haji Othman	Jabatan Kerjuruteraan Alam Sekitar, Fakulti Kejuruteraan Awam, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia

Fam Kim Pow	PO Box 10540, 50716 Kuala Lumpur, Malaysia
Assoc Professor Dr Fauzi Abdul Samad	Civil Engineering Faculty, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
Richard Franceys	WEDC, Loughborough University of Technology. Loughborough, Leicestershire LE11 3TU, England
Ghazali Daud	Pejabat Pengarah Bekalan Air, Tingkat 3, Wisma Negeri, Kuala Terengganu, Terengganu, Malaysia
G Ghosh	c/o Department of Rural Development, Room No 249, Krishi Bhavan, New Delhi 110 001, India
Haji Abdullah Mohd Ali	Public Relations Unit, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
Han Yean Toon	Jabatan Bekalan Air, Negeri Perak, Jalan St John, 30200 Ipoh, Perak, Malaysia
Hashiman Talib	Civil Engineering Faculty, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
Husain Hassan	Yang Dipertua, Majlis Perbandaran Kota Bharu, Kelantan, Malaysia
L G Hutton	WEDC, Loughborough University of Technology, Loughborough, Leicestershire LE11 3TU, England
Hubert Jenny	Jabatan Sains Alam Sekitar, 43400 Serdang, Selangor Darul Ehsan, Malaysia
Kamaruddin Che Lah	Majlis Perbandaran Seberang Perai, Jalan Datuk Hj Ahmad Said, 12000 Butterworth, Pulau Pinang, Malaysia
Kamsiah Mohd Ismail	Fakulti Kejuruteraan Awam, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
Khasim Ismail	Facilities Administration Unit, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
H C Kariyawasam	293/4 Gorakapola, Galle Road, Panadura, Sri Lanka
Dr Kiyoshi Kawamura	Department of Environmental Engineering, Faculty of Engineering, Chiang Mai University, Chiang Mai 50002, Thailand
Hing Koj Yin	No 1 Jalan 1/4, Jabatan Kemajuan Bangi, 43000 Kajang, Selangor Darul Ehsan, Malaysia
Peter Kolsky	OXFAM-PNP, c/o ICRC, PO Box 11-1492, Bangkok 10110, Thailand
Koo Hock Song	Majlis Perbandaran Pulau Pinang, 13th Floor Komtar, Penang, Malaysia
Dr Suporn Koottatep	Head of Department of Environmental Engineering, Faculty of Engineering, Chiang Mai University, Chiang Mai 50002, Thailand
Jon Lane	WaterAid, PO Box 4231, Kathmandu, Nepal
Ir Lim Chee Hua	20th Floor Plaza IGB, Jalan Kampar off Jalan Tun Razak, Kuala Lumpur, Malaysia

Mohammad Rafee Majid	Department of Town and Regional Planning, Faculty of Built Environment, Universiti Teknologi Malaysia, 81300 Skudai, Johor, Malaysia
Megat Johari M Mohd Nor	Jabatan Kejuruteraan Awam, Fakulti Kejuruteraan, Universiti Pertanian Malaysia, 43400 Serdang, Selangor Darul Ehsan, Malaysia
Misman Ramly	Academic Secretariat, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
Mohd Jamal Sulaiman	Jabatan Bekalan Air, Daerah Ulu Selangor, 44000 Kuala Kubu Bharu, Selangor Darul Ehsan, Malaysia
Assoc Professor Dr Mohamad Noor Hj Salleh	Civil Engineering Faculty, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
Mohamad Pauzi Zakaria	Department of Environmental Sciences, Universiti Pertanian Malaysia, 434 Serdang, Selangor Darul Ehsan, Malaysia
Dr Mohd Ismail Yaziz	Jabatan Sains Alam Sekitar, Universiti Pertanian Malaysia, 43400 Serdang, Selangor Darul Ehsan, Malaysia
Mohammad Naim Yaacub	Bahagian Kejuruteraan Awam, Politeknik Ungku Omar, Jalan Dairy, 31350 Ipoh, Perak, Malaysia
Mohd Asri Md Nor	Civil Engineering Faculty, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
Mohd Noor Othman	Civil Engineering Faculti, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
Mohd Saifuddin Yong	Syed Muhammad, Hooi and Binnie Sdn Bhd, Bangunan Bank Hong Kong, No 2 Leboh Ampang, 50784 Kuala Lumpur Malaysia
Mohd Zahry Othman	Civil Engineering Faculty, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
Heini Muller	c/o SATA, PO Box 113, Kathmandu, Nepal
Mustafa Kamal Abu Bakar	23 Jalan Harapan, 34000 Taiping, Perak, Malaysia
Chandran Nair	24 Soi Aree 5, Pnahonyothin, Bangkok
Nasiman Sapari	Department of Environmental Sciences, Universiti Pertanian Malaysia, 43400 Serdang, Selangor Darul Ehsan, Malaysia
Poshan Nath Nepal	Department of Water Supply and Sewerage, Pami Pokhari, Kathmandu, Nepal
Gaspar E Nepomuceno	8th Floor, Strata 100, Building Emerald Avenue, Ortigas Complex Pasig, Metro Manila, Philippines
Ng Boon Hwee	No 5 SS2/51, 47300 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Ng K C	53 Jalan SS21/56B, Damansara Utama, 47400 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Euan R Nichol	17 Palmer Avenue, Balwyn 3103, Australia
Nik Fuaad Nik Abllah	Universiti Sains Malaysia, Pulau Pinang, Malaysia

Noor Rihan Idris	Treasury, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
Dr Peter I Okoye	PO Box 1263, Islamabad, Pakistan
Eng Ong Chuan	Penang Water Authority, Level 33 Komtar, 10000 Pulau Pinang, Malaysia
F S A Pavamani	Senior General Manager, Tata Consulting Engineers, 34 Sant Tukaram Road, Carnac, Bombay-400009, India
Dr Charles Pendley	I Kruger, Gladsaxevej 363, 2860 Soborg, Denmark
Lawrence F Philpott	Coopers & Lybrand, Plumtree Court (PC 203), London EC4A 4HT, England
Professor John Pickford	WEDC, Loughborough University of Technology, Loughborough, Leicestershire LE11 3TU, England
Geoffrey A Piggott	Binnie & Partners, Level 7, 124 Walker Street, North Sydney 2060, Australia
Chandran D Ponniah	No 14 Jalan 20/16A, Paramount Gardens, Petaling Jaya, Selangor Darul Ehsan, Malaysia
Dr Rahmalan Ahmad	Fakulti Sains, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
Ramlan Abd Aziz	Fakulti Kejuruteraan Kimia dan Sumber Asli, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
Ramli Ibrahim	Lot 12, Persiaran Selangor, 40000 Shah Alam, Selangor Darul Ehsan, Malaysia
John Richardson	Watson Hawksley Asia, 20 Maxwell Road, 13-00 Maxwell House, Singapore
Romli Mohamad	Lembaga Kemajuan Wilayah Pulau Pinang, 27-29 Jalan Selat, Taman Selat, 12000 Buterworth, Pulau Pinang, Malaysia
Rosnawati Othman	Jabatan Senibina, Fakulti Alam Bina, Universiti Teknologi Malaysia Skudai, 80990 Skudai, Johor, Malaysia
Rusman Rais	Civil Engineering Faculty, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
Gary Shook	Box 78, 20700 Kuala Terengganu, Malaysia
Dr J C Srivastava	R-1 Green Park Ext, New Delhi 110016, India
Rowena Steele	WEDC, Loughborough University of Technology, Loughborough, Leicestershire LE11 3TU, England
Christina Subagio	P4L-DKT, JL HR Rasuna Said, Jakarta Selatan, Indonesia
Tang Siu Lam	PO Box 71751, Kowloon Central Post Office, Hong Kong
Chris Timbrell	Coopers & Lybrand, Plumtree Court, London EC4A 4TH, England
Tsen Kui Loi	LPPB No 1, Jalan Istana, 88644 Kota Kinabalu, Sabah, Malaysia

Dr N K Upadhyay	Professor and Head of Department of Zoology, 19 J Road, Jamshedpur-831001, Ranchi University, India
Axel Van de Veegaete	Belgian Red Cross, Vleurgatsesteenweg 98, 1050 Brussels, Belgium
Wang Chung Ta	JKR Pahang Kompleks Tun Abdul Razak, Bandar Indera Mahkota, 25582 Kuantan Pahang, Malaysia
Alistair Wray	WEDC, Loughborough University of Technology, Loughborough, Leicestershire LE11 3TU, England
Zainal Abidin Saidun	Jabatan Bekalan Air Selangor, Jalan Pantai Baru, Kuala Lumpur, Malaysia
Zainuddin Hj Omar	3157 Lembah Ledang, Kuala Lumpur, Malaysia
Zainuddin Hj Shamsudin	Civil Engineering Faculty, Universiti Teknologi Malaysia, 54100 Jalan Gurney, Kuala Lumpur, Malaysia
Zakariya Hj Abdullah	Faculti Perhutanan, Universiti Pertanian Malaysia, 43400 Serdang, Selangor Darul Ehsan, Malaysia
Zamri Chik Haji	Perbadanan Kemajuan Negeri Selangor, Persiaran Barat off Jalan Barat, 46505 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Zubir Hj Ahmad	Jabatan Kejuruteran, Majlis Perbandaran Seberang Perai, Jalan Datuk Haji Ahmad Said, 12000 Butterworth, Pulau Pinang, Malaysia

Delegates on the final day of the 14th WEDC Conference in Kuala Lumpur 11-15 April 1988

14th WEDC Conference

Water and urban services in Asia and the Pacific

Kuala Lumpur 1988

Speech

Professor John Pickford
WEDC, Loughborough University of Technology

On behalf of the Water, Engineering and Development Centre I extend to you all a very cordial welcome to this 14th WEDC Conference. It's good to re-establish contact with those we already know and we are already making new friendships here in KL.

This week we are dealing with water supply and sanitation. As the International Drinking Water Supply and Sanitation Decade draws to a close we are looking forward to further endeavours to bring about "Health for all by the year 2000". Housing and roads and a whole range of other services can enhance the health and well-being of individuals and communities in Asia and the Pacific.

WEDC is particularly involved with underprivileged people - those with low incomes or no income at all. But in Asia and the Pacific there are also problems for which the most appropriate technology may be sophisticated and complex - for example industrial pollution.

The problems we are looking at this week cannot be solved by technology alone (whether it is simple or high-tech). We are working with people of different social and cultural backgrounds. We need good management, sustainability, good operation & maintenance.

I welcome you on behalf of WEDC. We hope you will get to know us all well, so I'm going to introduce the WEDC contingent. Many of you have corresponded with the Conference Secretary, Rowena Steele. Also here are Morag Bell, Andrew Cotton, Richard Franceys, Len Hutton and Alistair Wray.

I hope you all enjoy this week and learn much that is useful from each other.

14th WEDC Conference

Water and urban services in Asia and the Pacific

Kuala Lumpur 1988

Speech

Datum Amar Stephen K T Yong,
Minister of Science, Technology and Environment, Malaysia

Saya merasa sangat sukacita untuk memberi sepatah dua kata sempena Persidangan WEDC Ke 14 yang bertema "Air dan Perkhidmatan Bandar di Asia dan Pasifik". Tahniah saya ucapkan kepada Universiti Teknologi Malaysia dan Loughborough University of Technology, United Kingdom di atas usaha untuk menganjurkan persidangan ini.

Air adalah merupakan suatu sumber yang amat penting untuk membenuhi keperluan manusia. Ianya dianggap sebagai kunci ke arah pertumbuhan dan kemakmuran ekonomi. Pembangunan negara adalah sangat bergantung kepada adanya sumber air yang mencukupi baik untuk kemajuan industri mahupun untuk keperluan harian manusia. Dalam pada itu, adalah penting supaya usaha diambil untuk memuliharakan air dan sumber-sumbernya supaya pada masa hadapan, ianya masih dapat digunakan untuk keperluan negara. Di samping itu, perhatian perlu juga diberi kepada perkhidmatan bandar seperti sistem pembetungan dan pelupusan pembuangan domestik supaya kualiti hidup masyarakat di bandar dapat diperlihara dan seterusnya ditingkatkan.

Saya berharap para peserta di dalam persidangan ini akan dapat memberi pandangan yang bernas serta dapat bertukar pengalaman dan pengetahuan demi mencapai matlamat persidangan WEDC ini.

Saya mengucapkan selamat maju jaya dan selamat bersidang.

14th WEDC Conference

Water and urban services in Asia and the Pacific

Kuala Lumpur 1988

Speech

Professor Madya Dr Fauzi A Samad
Universiti Teknologi, Malaysia

Saya bersyukur ke hadrat Ilahi kerana dengan izinNya dapat bersama-sama dengan rakan-rakan sejawat yang lain menganjurkan Persidangan WEDC ke 14 yang bertemakan "Air dan Perkhidmatan Bandar di Asia dan Pasifik". Persidangan-persidangan WEDC yang lepas-lepas telah menjadi persidangan antarabangsa yang penting dalam hal pembangunan bafi negara-negara membangun. Oleh kerana Malaysia adalah satu-satunya negara yang giat menyediakan kemudahan asas bagi semua peringkat rakyatnya terutama sekali mereka yang kurang bernasib baik, maka wajarlah bagi persidangan seumpama ini diadakan di Malaysia. Moga-moga banyak menafaat yang akan diperolehi.

Adalah menjadi tujuan utama persidangan ini untuk mengumpulkan pegawai-pegawai yang bertanggungjawab dalam menyediakan kemudahan asas untuk masyarakat seperti dari majilis-majilis bandaran, jabatan kerjaraya, kementerian-kementerian kesihatan, sains, teknologi dan alam sekitar, agensi-agensi kerajaan yang lain termasuk pusat-pusat pengajian tinggi dan badan-badan swasta dari firma-firma perunding, pembuat-pembuat, pembekal-pembekal, pemborong-pemborong dalam satu majlis. Pada prinsipnya persidangan ini adalah dikhaskan kepada mereka yang benar-benar terlibat dengan tema yang dipilih.

Besar harapan para penganjur bahawa tema yang dipilih bagi persidangan WEDC ke 14 ini bersesuaian dengan kehendak masyarakat dan keperluan semasa bagi kawasan rantau Asia dan Pakifik. Penghijrahan beramai-ramai penduduk kampung ke bandar-bandar untuk mencari naikah adalah satu phenomenon yang berlaku dengan pesatnya di negara-negara Asia dan Pasifik. Untuk menyediakan kemudahan asas bagi mereka ini yang kebanyakannya adalah golongan yang berpendapatan rendah telah menjadi satu masalah yang besar. Persidangan ini sudah pasti tidak akan dapat menyelesaikan masalah yang dihadapi tetapi harapannya ialah supaya beberapa penemuan penting dan cadangan dari penyelidik dan cara perlaksanaannya dibincangkan dalam satu forum yang berbentuk antarabangsa.

Pihak penganjur mengucapkan berbanyak-banyak terima kasih kepada semua yang terlibat yang telah memberikan sokongan, kerjasama dan bantuan untuk menjayakan persidangan ini. Akhirnya segala apa yang diharapkan dari persidangan ini dipohonkan supaya dimakbulkan Allah.

English translation

The honourable Minister of Science, Technology and Environment, Datuk Amar Stephen Yong, the Vice Chancellor of Universiti Teknologi Malaysia, Tan Sri Dato' Ainuddin Abdul Wahid, Professor John Pickford, distinguished guests, ladies and gentlemen.

Theme The theme chosen for this Conference is "Water and Urban Services in Asia and the Pacific". Many of the countries in Asia and the Pacific are experiencing a rapid rate of urbanisation and are facing serious problems associated with providing adequate facilities for basic human needs. Thus we feel that the choice of this theme is timely and appropriate.

Urbanisation Problems A social problem among developing countries is the migration of rural population, particularly the young, to cities in the hope of employment and improved living conditions.

This influx of people has caused several problems for urban areas:
(1) population explosion and insufficient space and facilities;
(2) lack of resources to cater for the increased demands;
(3) competition for limited resources by increased industrialisation.

For example, the estimated population for the Malaysian Federal Territory in the 20 years between 1980 and the year 2000 will be an increase from 1 to 2.2 million.

Squatters Those who migrate are normally poor. As they cannot afford established facilities, the only alternative is to construct their own shelter on unoccupied land.

In the Federal Territory in 1980 near one quarter of a million people were squatters, occupying 10% of the total area of the territory (4,400 ha). The increase in the number of squatters between 1974 to 1980 was 10% annually.

Obvious difficulties faced by squatters include:
(1) housing that is overcrowded, haphazard and unsafe;
(2) inadequate or sometimes non-existence of infrastructural facilities such as water supply, electricity, sewerage, drainge and roads;
(3) lack of other facilities like schools, health care and recreation areas.

Water Supply Due to the rapid increase in urbanisation, provision of adequate potable water supply has been a major challenge. As an example, for the 20-year period to the year 2000, the Federal Territory requires a three-fold increase in supply from 60 mgd to 180 mgd. According to the Klang Valley report, for the same period, industrial water requirement will increase likewise from about 10 mgd to 30 mgd. If these projected demands are not met, there would be adverse effects such as:
(1) reduction in economic growth and industrial development;
(2) domestically, it could lead to social problems.

Sanitation Along with rapid urban expansion, there is always a shortfall in coping with the treatment and disposal of sewage. From a survey made for Salak South area in Kuala Lumpur, 53% of the population had no specific method of waste disposal. Of the other 47%, 3% used rivers and drains, 21% used the bucket method and only 23% had flush toilets.

Improvement It is the responsibility of planners, engineers, policy and decision makers to improve the safety, health and well-being of the people. This can be achieved through such measures as:
(1) planned resettlement of squatters;
(2) sufficient quality water supply;
(3) proper sanitation;
(4) upgrading of roads, drainage systems and flood mitigation measures.

Conference Objectives It is therefore, the aim of this Conference to:
(1) help in suggesting suitable alternatives for planning and development;
(2) propose how to to improve the level of comfort and raise the standard of living for those with low income;
(3) update the planning and development of water resources techniques.

Conference Organisation The objectives will be achieved only by sharing ideas and exchanging experiences. This gathering has experts in various disciplines, agencies, from different countries. The Conference is organised to encourage maximum interaction among participants by including formal presentation, poster sessions, discussion groups, a technical tour and social functions.

Finally, I would like to welcome all delegates to the Conference and I hope we will have a fruitful discussion. Thank you to all who made this gathering possible.

14th WEDC Conference

Water and urban services in Asia and the Pacific

Kuala Lumpur 1988

Rural water supply – W Timor Indonesia

Euan R Nichol

INTRODUCTION

Background

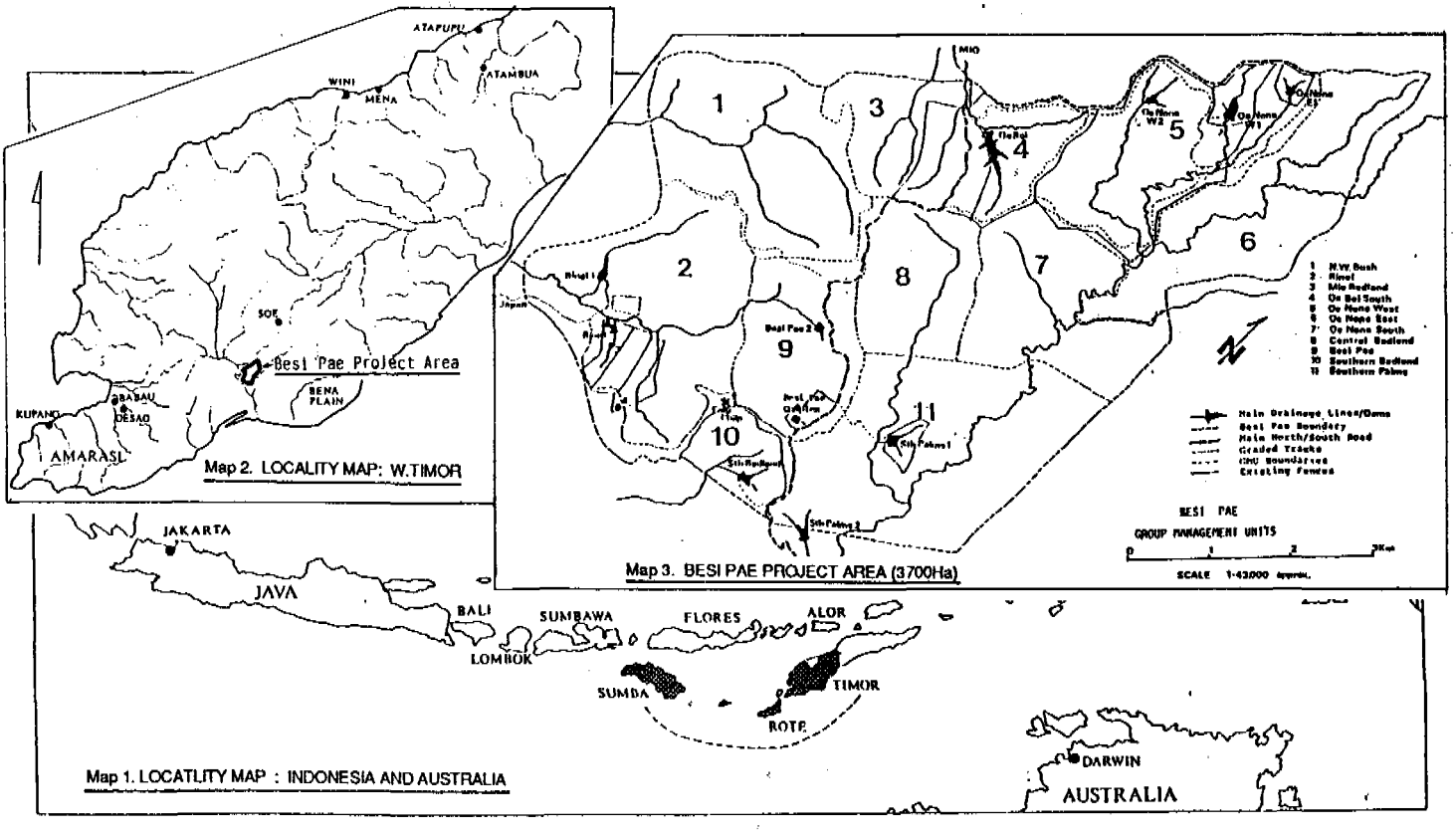
West Timor is part of the major island in the Indonesian outer arc province of Nusa Tengara Timur (Map 1). Due to factors such as adverse climatic conditions, poor soils, severe soil erosion, shifting agriculture, extensive cattle grazing, a high population density and a lack of water, it has one of the lowest per capita incomes in Indonesia.

For the village people living at a subsistence level, a highly variable wet season and a long dry bring epidemic disease and hunger. It is at this time that people and animals may have to share limited polluted water sources. Thus the key to improving health and living standards is the supply and maintenance of adequate unpolluted water sources.

In 1982 the Australian Development Assistance Bureau (ADAB) and the Indonesian Government working through an agricultural consulting company and the livestock department respectively, started a two-year pilot project. They sought to formulate an appropriate dry land farming model/s, that could be replicated in other areas of the province in order to arrest the increase of rural poverty and the decline of the ecosystem.
The pilot project was an attempt to try various known techniques and determine the most appropriate for this area, with a view to use in subsequent expanded phases.
This paper deals primarily with the water resource development.

Geography

Timor and the other outer arc islands, unlike most of the other islands of Indonesia are non volcanic in origin, being of recent raised marine sediments ($5x10^6$ years old). With the highest point at over 2400 m the area is generally very rugged and diverse.
The geomorphic processes are still very active so much of the steep hillside is highly disected and unstable.
The geology is complex.
Below an upper raised coral crust and a limestone marl series lies a massive, both in depth and area, montmorillonitic clay series (Bobonaro).



Climate

The climate is affected by Timor's proximity to Australia. Typically a low, highly variable rainfall falls between December and March with a long hot dry season and high evaporation over the rest of the year. Rainfall comes with the western monsoon thus the western side of the island tends to receive the most rain. However, the mountainous topography produces a range of variable micro climates.

Hydrologically, the rainfall on the raised coral and limestone marl areas produces perennial springs of high quantity and quality, but these areas are relatively small. Semi arid conditions prevail when a long dry season occurs on land systems of the Bobonaro clay series.
Lack of drinking water for livestock and man during the dry season prevents utilisation of the grasslands and concentrates overgrazing and environmental deterioration around permanent waters.

THE BESI PAE PROJECT

The project site

Approx. 3700 ha of land was selected near the village (Desa) of Mio (Map 2 & 3). The area was sparsely populated, with under utilized grassland. It lacked permanent water and had a variety of topographical features including flat plains, limestone capped ridges, undulating grasslands and highly dissected valleys.
A project centre consisting of dormitories, living quarters, training centre, meteorology station, workshop and storage area was established on the main district road 96 km and 3 hours drive from Kupang the provincial capital (Map 2).
The original project design called for the land to be divided into Group Management Units (GMU). Each unit would have a small dam, a fenced foodcrop area and an upgraded animal grazing area to settle a group of families. The topographical catchment became the logical division of Group Management Units.

Water resource development

Catchment filled storages with earth banks of less than 10 m height are an accepted method of providing stock and domestic water supplies in rural Australia. It is estimated that about US$30 million is spent each year in rural Australia on small dam construction (1). Thus the use of these proven techniques as applied to the Timorese environment was the first approach to water conservation in the Pilot Project Area.

Dam construction is a relatively new concept in Timor. Small dams called check dams have been built to a common design of a full height concrete core and steep hand or machine placed batters of the local material. Spillways are formed with unreinforced concrete floors and masonry sides. Despite the fact that their performances have only been fair with high rates of bank seepage and spillway failures the idea of building dams with earth alone was met with a high degree of incredulity.

Dam location and siting

Many factors affect the dam siting decision process.
The catchment area yield must be sufficient to fill the storage for a given return period, in this case, each year. On the other hand, large flood flows - a function of the catchment size - present difficulties in spillway design, construction and maintenance. The skill is to try to match catchment yield to storage volume.
The storage/excavation ratio is the economic function of the dam. The steeper the drainage line gradient the smaller the stored volume relative to each volume of placed embankment material. The aim is to maximise this function.
Dam surface area, in this particular situation, needs to be minimised for a given stored volume as the evaporation losses (approx 2 metres) are high. Thus the dams need to be deep (greater than 6 m) with a minimum area of shallow water at the maximum capacity.
Other topographic features may provide a site which can minimise earthworks costs. A suitable area for safe disposal of flood flows back to the drainage line also needs to be identified.
Insitu materials at sites need to be identified for their ability both to provide a stable impervious bank and to retain water within the storage without excessive seepage loss. Seepage tests were undertaken at some sites.
The location of storages near to the users is an obvious desirable factor. Women in the Timorese society are the water carriers and for some in the project area this meant daily treks of over 20km. Usually the above criteria; i.e. topography, materials and suitable catchments controlled site selection. However by piping water and water tank construction, the time and effort in water carrying was substantially reduced.

Dam design and construction

Thirteen (13) dams of varying type and size were constructed during this pilot phase. (Table 1.) General Cross sectional design of the banks is shown. (Diagram 1.)

Table 1

NO.	IN ORDER OF CONSTRUCTION	EARTHWORKS (CuM)	STORAGE CAPACITY (Ml)	MAX WATER HEIGHT (M)	STORAGE EXCAVATIONS RATIO	UNIT COST EARTHWORKS ($A/CuM)	CATCHMENT AREA (Ha)
1	Binei 1	5080	17.5	6.0	3.4	2.42	86.0
2	Binei 2	685	1.0	2.4	1.5	3.98	2.0
3	Binei 3	3460	6.3	5.2	1.8	1.98	8.0
4	Besi Pae 1	3200	5.0	5.2	1.6	1.27	6.0
5	Oe Boi	9300	60.0	7.5	6.5	1.47	70.0
6	Binei 4	1950	4.4	3.6	2.3	1.72	2.5
7	Besi Pae 2	5000	8.8	8.0	1.8	1.15	4.0
8	Oe Noni W1	10450	28.8	7.8	2.8	1.98	28.0
9	Oe Noni E1	7250	9.6	7.3	1.3	2.13	8.0
10	Oe Noni W2	3640	14.6	6.4	4.0	2.54	10.0
11	South Palms	4400	12.1	6.3	2.8	2.22	15.0
12	South Badlands	5300	9.2	6.2	1.7	1.60	10.0
13	Maiskolen (South Palm 2)	13100	16.3	5.7	1.2	2.04	22.0

The equipment used was a Komatsu D65E bull dozer, a small 4 tonne vibrating pad foot roller, a 4000 litre water tank with spray bar on a trailer towed by a tractor or on the back of a 4WD truck.
The construction methods used were certainly not low technology, but were conventional and conservative bearing in mind that these earth dams had to work. The methods could be replicated by suitable trained personnel from either the Public Works Department or private contractors.

1. Site cleared, top soil stripped and stockpiled for recovering bank.
2. Cut off to bank excavated and backfilled with selected clays.
3. 50 mm diameter galvanised steel outlet pipe with rubber cutoffs (anti seep collars) from truck wheel inner tubes. Cut into fill, laid back filled and hand compacted.
4. Bank material pushed up, spread evenly 150mm layers, moisture added and rolled to maximum density.
5. Near top of bank, trickle pipe laid through bank 1.2 m below FSL. A concrete block inlet structure was later constructed.
6. Spillway/s cut to discharge to best available disposal area.
7. Topsoil brought back to cover bank.
8. Bank and spillway planted down to appropriate running grasses.

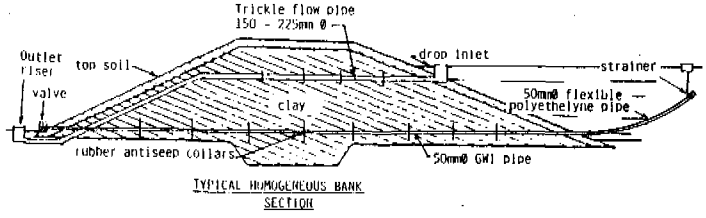


Diagram 1

Catchment performance

Each storage was surveyed on completion and meter depth gauge boards levelled into position.
The storage volume was calculated allowing a storage volume to stage (water depth) relationship to be established.
Rain gauges were placed on each dam or in a central position if there were several dams close together.
Daily rainfall and water depths are read by the local community appointed and project trained Jaga Air (water watchman). To this data is added daily readings from the Met Station at the project buildings of Pan A evaporation figures, and more recently Pluviometer rainfall intensity data.

Over a long time period a fair assessment of catchment yield performance in terms of runoff megalitre (Ml)/area(ha) will be obtained allowing compilation and confirmation of local values of the parameters for the United States Department of Agriculture Soil Conservation Service Daily Rainfall Runoff Model. (USDA Model) (2). Initial results indicate catchment yields ranging from 0.5 Ml/ha/yr to 1.3 Ml/ha/yr with average 0.1 Ml/ha/yr.

Dam performance

The ability of the storage to hold water during the dry season can be assessed by accounting for all losses from the storage. Evaporation losses are obtained from pan figures mm/day. Abstraction volumes are metered or guestimated from population and stock usage, leaving only the seepage losses unaccounted in the total loss/day from daily dam height readings. Early dams built on limestone based country have shown high losses while those on the Bobonaro clay land systems have performed well.

Given the highly variable nature of the rainfall in West Timor the on going performance of the pilot dams, should provide a good data base for the future dam design.

It was recognised from the outset that provision of large bodies of still water could exaserbate the existing critical Malaria problem. Two species of surface feeding fish (Ikan Tilapia and Ikan Mas) were introduced to the larger storages. Subsequent negative water sampling for mosquito lavae and no increase of incidence of the disease would indicate that the dams have not added to the scourge of this island.

Water Usage

Water is reticulated from the storages through handlaid black polyethelyne piping to covered concrete water tanks. Separate tanks were constructed for human and animal use.

The water level in all tanks was float controlled with the floats being well protected from user manipulation. Pipe sizes were designed to minimize losses should a pipe breakage occur. This, however, has brought problems with supply, as increasing demands have lead to villagers tampering with the pipe system. A redesign using a break storage tank and a larger diameter delivery pipe has eased this situation.
The peoples tank was usually located near or within a fenced communal garden area. Water was still carried from the tanks to the home in the traditional manner by the women of the village but the distance/time was reduced. Time and water was now available for cultivation of dry season vegetables by the village women. Although initially these were sold as cash crops to the passing traffic, succeeding seasons have shown a much greater incorporation of this produce into the villagers diet. At some of the peoples tanks washing cubicles were constructed. Using carried water (to limit consumption) the villagers could regularly wash during the dry season (something not previously possible) with the residue running on to the vegetable gardens.
The animal tanks were sited separately on well drained flat areas.

Conclusion

Small earth dams (Dam Tannah) of conventional design and construction could be built and performed satisfactorally in the Timorese environment.
Dam siting was critical. However with the establishment of a land system map of the project area (and later over much of West Timor) key areas with desirable features have been identified. Thus less experienced personnel can rapidly hone in on possible sites that need to meet population and animal criteria.
Spillways and spillway returns perceived at the beginning as potential problem areas have performed well except in the extreme condition - when they are really needed. A one in 20 years return storm (est) Feb. 86 left some of the spillway returns in need of major repair. Some recent research in the U.K. on alternative (to reinforced mass concrete) more natural solutions may provide directions for solving this ongoing problem.

This project has moved into an expanded 2nd phase at two other locations in West Timor. Further Indonesian Government Institutions are involved with an ever increasing local community involvement in the planning, construction and maintenance of the dams, food crops and pastures.

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14th WEDC Conference

Water and urban services in Asia and the Pacific

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Management of drinking water in drought

G Ghosh

The water crisis has become the central theme for Indian Planning process during this decade. Paradoxically this situation happens to coincide with the International Decade of Drinking water. Today in India we are face to face with an acute water scarcity that is posing a grave threat to the development and growth of the nation.

Drought

While drought means a deviation from normal rainfall the term is used rather freely in India. However the most alarming and exponential increase in water scarcity over the last few years cannot be linked exclusively to this factor as there has been no long term change in rainfall (Mooley, Parthasarathi 1984)[1]. It is the distribution of rainfall which is changing and as due to the deforestation surface run-off increases and top soil cover is removed fast, the recharging of groundwater proportionately reduces. Excessive pumping of groundwater can create an almost irreversible position even if the rainfall and soil condition remains good. Rain water, surface water, groundwater, soil moisture are part of a total water system and are inseperable, linked to each other and the problem has to be looked into in totality and not in isolation of drinking water scarcity only.

Although the surface water sources are the main water resources for urban and some rural drinking water supply, they are the primary victims of the drought. The maintenance of the hydrogeological capacity of these reservoirs has so far not been recognized as a step in sustaining water resources. Moreover in the summer the loss due to evaporation of whatever the water resources left out are to the tune of 60-70% and thus aggravate the problem.

Year round availability of surface water is not only essential for irrigation but it is the only source for large supplies to the urban industrial sector and for hydro-power generation. Surface water drought thus undermines all these activities as has been seen in the current year.

"The reason has been that water resources development in India has cognitively been limited to utilization and has not touched ecological husbandry. Thus we are left with increasing competition for a decreasing resource. The crisis in surface water is mainly due to the collapse of water conservation in the upper catchments. Large areas of the country are also affected by two other vital forms of drought - scarcity of moisture in soil for plant growth and scarcity of groundwater for both domestic and irrigational purposes". (Bandopadhyaya J 1987)[2].

1987 Scenario

With the failure of monsoon of 1987, 15 States of the Union including nearly 90,000 villages and 300 towns faced drinking water scarcity. In some areas like Gujarat, Rajasthan this year is the third drought year in succession and the surface water was almost totally inexistence in some parts in these areas.[3]

Urban Water Supply

The fragility of the urban water supply system in tropic and semi-tropic region had been fully exposed when this sector faced serious crisis in recent drought. The rapid urbanisation, industrialization far exceeded the water supply systems established. Metropolitan cities like Madras, Hyderabad, Bangalore, Jaipur, Rajkot which in recent years had shown high growth rates faced serious crisis. For Madras and then for Rajkot water had to be moved through rail tankers over

long distance while in the same city of Rajkot a sewerage scheme based on 140 litres per capita water supply is crawling in its implementation! The emphasis laid on the distribution and purification system without a flexible source had exposed the weaknesses in areas of source development, source sustainance, recycling of waste water and above all planning for total water management.

Problem of Growth

The major problem these urban and rurban growth centres face today is the exponential increase in population due to migration as well as industrialization. Water was never considered as a finite natural resource and hence never was considered a problem to match such a growth. The water potentiality and the unit cost of water in a sustained supply basis was never taken into consideration in regional or town planning. The fragile eco-system on which such pockets of growth were based could not sustain and become highly sensitive. With slight variation in rainfall or a change in distribution, the systems tend to collapse. The earlier warnings of Madras or Hyderabad went without much notice. The degradation of urban ecological system was much more severe than the rural scenario. That the urban growth centres cannot have unlimited supply of the natural resource at the expense of rural areas and the growth has to be conjunctive to support each other has now been felt in time of crisis.

Immediate Government Action

To give a boost to the International Decade Programme in Rural Drinking Water Supply Programme and to develop an appropriate technology mix a "National Technology Mission on Drinking Water" had been launched by Government of India in 1986. The Mission was aimed to develop a holistic approach towards the problem though primarily the rural drinking water problem but focussed also to the total water management.[4] This National Technology Mission had been launched with a view to change the life of an ordinary man in the villages through the application of science and technology. Primarily however this Mission is a societal one. The ambitious goal of the Mission is to cover 2.27 lakh villages in the Seventh Plan, i.e., by 1990 which incidentally matches the International Decade. The target of the country of 100% coverage of rural population by supply of safe drinking water is the goal of the Mission. This will be achieved through development of appropriate cost effective technologies through community participation and development of a nation-wide management information system for project planning, implementation, evaluation and decentralised maintenance.

With the works of the Mission being under implementation and with the early indications of the drought Government immediately decided to have a contingency plan. The problem areas were divided into sub groups and action plan had been formulated to meet the crisis situation and to dovetail into the works of the Mission. Briefly the problems and the actions taken have been listed as follows:

Rural Drinking Water Supply: Problems due to Drought (a) Lowering of water tables, (b) sources dry up, (c) power shortages lead to lowering the capacity of the system, (d) systems based on surface sources dry up, (e) pollution problem aggravates, (f) problem of cattle drinking water becomes serious, (g) mechanical failures add to the problem, (h) lesser capacity of the system needs augmentation.

Urban Drinking Water Supply: Problems due to Drought (a) Mostly surface sources - dry up, (b) due to poor distribution system - unequal distribution, (c) more demand - less supply, (d) new sources located in rural areas - creates social tension, (e) high demand from industry, (f) sewerage system gets affected (g) shift from mechanical to manual distribution creates management problem.

Action Plan

The problem had been tackled in both short as well as medium plan action in the overall context of the long term plan and its objectives.

Short term measures include (a) Department of Rural Development

being declared as the nodal agency for both rural and urban areas for better coordination, (b) water targetting through satellite imageries, geophysical and geohydrological exploration started, (c) source development through proper scientific drilling, (d) reservation of all water in irrigation dams for drinking water purposes in difficult areas, (e) programmes for extension of pipelines, augmentation of source and massive rejuvenation programmes have been given priority, (f) completion of projects under implementation on priority basis in difficult areas, (g) concentration on most difficult areas like Gujarat, Rajasthan etc., (h) mobilisation of manpower and equipments in all sectors for drinking water programmes, (i) computerization of monitoring system.

Medium term measures include immediate action for (a) procurement of drilling rigs - indigenous as well as imported through UNICEF, and other bilateral programmes. The most important one is Indo-UK bilateral programme, (b) procurement of geophysical equipments like electrologger, terrameter, hydrofracturing equipments etc. (c) massive training programme organised for geophysical surveys as well as for drilling programmes, (d) large number of structures for both water harvesting as well as for artificial recharging of aquifer, (e) composite plan of water distribution made upto the next monsoon for both rural as well as urban areas, (f) strengthen urban distribution systems, (g) emergency distribution systems laid for new sources, (h) massive awareness programme for individual and community participation in water conservation measures started.

Long term measures include proper legislations introduced to control the ground water withdrawl for use of water for industry and water intensive agriculture and effective implementation of National Water Policy.

Non-conventional Measures

Various non-conventional measures have also been introduced like Reverse Osmosis or Electrodialysis plants for desalination, installation of solar powered deep drilling pumps, defluoridation plants and high iron removal plants.

Awareness Campaign

It was evident that such a massive drought fighting programme cannot be implemented without active copperation of people. Media campaign had been launched through Television, Radio, Newspaper, Advertisements and a large number of awareness camps through voluntary agencies to meet the situation, to take care regarding water borne diseases and to ration the supply in areas of crisis. The reaction of people is spontaneous, patient and highly cooperative.

Maintenance

Majority of the problem lies in not maintaining schemes properly. Rejuvenation works are mostly due to failure of maintenance. In normal years the schemes are neglected and only in time of crisis the need of rejuvenation develops. This is also due to lack of peoples' involvement at the stage of implementation of the scheme and its normal maintenance.

Funding

Every year a massive programme of Rs.1000 crores is being implemented in the water supply and sanitation sector in the country besides during the time of drought another Rs.200 - Rs.300 crores are being spent for emergency measures. The effect of this massive programme is evident from the fact that inspite of having 4 mm to 8 mm rainfall in some areas, the scientifically developed water supply schemes have been sustained. Water has been provided both for human as well as cattle population and it is a fact that even in urban pockets facing grave crisis, migration has not taken place. Immediate measures like conservation of water through spraying of cetyl alcohol, reduction in the cosumption and little change in practice of water use in day to day life has made all the change.

The major problem of water supply and sanitation in the country is the non-involvement of the community. This drought has given us a lesson that increased community involvement is a must for creation of awareness about the finite nature of the resource.

The National Technology Mission on Drinking Water has already focussed its objectives towards this goal. The salient changes which is taking place in water and sanitation scenario since 1986 has enabled the country to face the worst drought of the century. Water supply is no longer looked in isolation but a holistic approach of forest, environment, agriculture, science and technology has changed its dimension.

The Public Health Engineering Departments in the States have been strengthened with Geohydrologists, Geophysicists, Economists and even Sociologists. Water supply is not purely a hardware problem. Involvement of women, the community, maintenance through handpump mistry programme are the methodologies which is bringing the change.

Conclusion

Although the massive programme launched would certainly meet the crisis today, in the long run the conservation of water and rain water harvesting may be the panacea for the arid and semi-arid region. Besides the deep aquifer, the surface and sub surface moisture had to be tapped properly. The delicate supply - demand situation has to be carefully handled particularly in the case of fast developing countries.

Acknowledgement

I am grateful to Shri V.C. Pande, Secretary, Department of Rural Development, Government of India for encouraging me in writing this paper.

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Water and urban services
In Asia and the Pacific

Kuala Lumpur 1988

Portable slow sand filter performance

Dr Mohammad Ismail Yaziz and Omar Din

INTRODUCTION

The importance of safe water supply and sanitation facilities has been recognised and approved, although not applied universally. They are both major environmental issues that are mutually related to and complement each other. Many epidemics of the past have been caused by the contamination of raw water by disease causing organisms.

In Malaysia, all urban dwellers have or have access to treated piped water supplies. For rural communities, approximately 65% of house owners have piped water supply connections. Nonetheless, for many communities living in squatter settlements in the urban areas, the supply of piped water is often inadequate to meet their needs and many resort to using other nearby sources of water for a variety of end uses (Ref. 1). They include water from unprotected wells, river water, rain water and also water from disused mining pools. Such sources may be unsanitary and is usually not appropriate for domestic use without suitable treatment. Several short-term studies has been carried out to assess the suitability of a household slow sand filter (SSF) module to produce potable water from raw mining pool water and other waters. Some preliminary test results are presented in this paper.

MATERIALS AND METHODS

Location

Six mining pools were selected for the water quality survey. These pools were within easy reach of users, has easy access and were free of aquatic plants and debris.

Samples

Water samples were abstracted from a depth of 0.3 m from the surface and about 4 m from the bank using a pump and one inch diameter pvc pipes fitted with a suction valve and a wire mesh screen at the inlet end Samples were stored in ice prior to analysis in the laboratory.

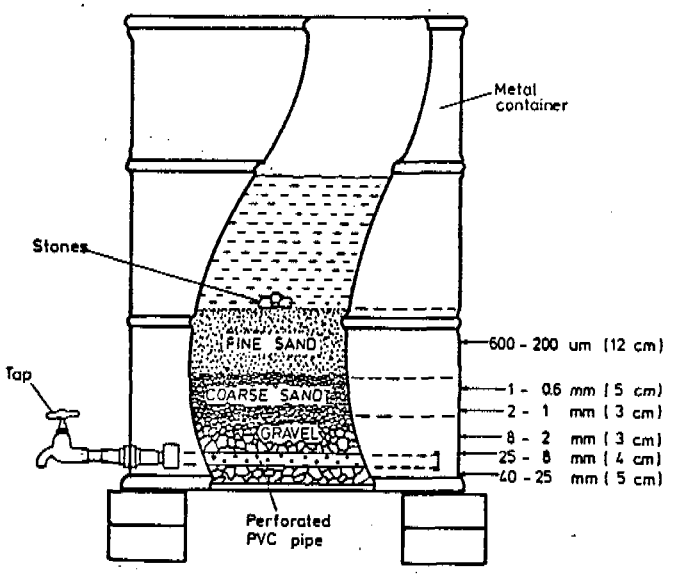
Slow Sand Filter (SSF)

The SSF module was constructed as show in Fig. 1. The module has a total volume of 0.21 m . The flow rate was maintained at a minimum of 0.01 m/h to 0.1 m/h (2 - 2.4 $m^3/m^2/d$) during the tests. The raw water feed tank was placed above the SSF and was manually stirred once every few hours. Samples were obtained from the outlet taps of both containers and analyzed as indicated below.

Analysis

All samples were analyzed for total coliforms (membrane filtration method), Biochemical Oxygen Demand (BOD 5 days), Nitrate Nitrogen , total solids, hardness, iron, lead, arsenic, turbidity, and temperature and pH (in-situ measurements). All analysis were carried out according to Standard Methods (Ref.2).

FIGURE 1 : THE SLOW SAND FILTER



RESULTS AND DISCUSSIONS

Theoretically, the water quality in any mining pool will depend on many factors such as the physical conditions surounding the pool, the type of vegetation in and around the pool, the age of the pool, and the geological nature of the soil, etc. However, their effects will be discussed in a general manner since detailed analysis of these

Table 1 : Average values of water quality at the pools studied.

Parameter/Pool No.	1	2	3	4	5	6
Coliform/100 ml	8983	7243	20275	7892	9650	8260
BOD (mg/l)	0.75	0.60	1.42	0.69	0.65	0.68
Total Solids (mg/l)	201.9	101.6	2003	135.2	158.3	144.0
Turbidity (NTU)	20	9	44	9	13	14
Hardness (mg/l)	84.4	80.2	100	74.8	81.0	76.0
NO3-N (mg/l)	0.28	0.23	0.37	0.28	0.30	0.25
Iron (mg/l)	0.89	0.52	1.23	0.53	0.58	0.55
Lead (mg/l)	0.02	0.03	0.01	0.02	0.02	0.01
Arsenic (mg/l)	0.01	0.01	0.00	0.01	0.00	0.01
pH	6.7	6.8	6.7	6.8	6.8	6.7
Temperature (C)	28.3	28.2	26.5	26.0	27.0	29.0

factors is beyond the scope and objectives of this study. The data in Table 1 shows that the coliform counts were highest for pool no. 3 compared to the other pools. This may be attributed to the discharge of sullage water from the houses located at the edge of the pool and possibly also due to run-off and contamination from pit latrines located near the pool. In comparison, the other pools exhibited markedly lower coliform concentrations with pool 2 showing the lowest value. The close values between pools 2 and 4 is rather surprising since their surroundings differ markedly ; pool 2 is located beside a major highway and has no houses located within 500 m of the edge of the pool whereas pool 4 has many squatter houses built on the edges of the pool. The BOD values of the pool waters were relatively low with a maximum of 1.42 mg/l ; waters with BOD values between 0.75 - 1.50 mg/l are considered suitable as sources of potable water (Ref. 3). With respect to solids, the highest concentration was found in pool 3. This may be due to sediment run-off from some construction and development activities on the eastern side of the pool during the study period. The lower total solids concentrations in the other pools may be attributed to the lack of similar activities and also because settling can occur easily in these quiesent deep pools with little recharge of solids from the bottom sediments. Except for pools 1 and 3, the turbidity values for the other pool waters did not exceed 14 NTU (average 18 NTU) and may be considered suitable as a potable water source. The relatively higher turbidities in pools 1 and 3 may be caused by the same factors as discussed earlier for the total solids concentrations. The water hardness and metals concentrations (except iron) are all within acceptable limits of the WHO guidelines for drinking water quality (Ref. 4). In general, the results of the survey of the water quality in the six disused mining pools indicate that the raw water is suitable for use as a potable water source after appropriate treatment. The extent and nature of the treatment would depend on the initial raw water quality characteristics and whether it is for individual house use or for community use. The presence of harmful contaminants must be carefully examined and evaluated against the treatment system to be applied to determine it's suitability.

For the SSF study, the water from pool 1 was used because it's water quality approximated the mean values of the water quality in all the pools studied and also because of it's location near (7 km) to the laboratory. Table 2 and Table 3 shows the removal efficiency for the selected water quality parameters after treatment in the SSF module on the 10th and 20th day of operation respectively.

The 94 to 97 per cent total coliforms removal after treatment shows that the SSF module has a good potential for producing potable water from disused mining pool water. Although the increase in filter efficiency was only 2 % from the 10th to the 20th day, the gains in terms of absolute numbers of bacteria removed was significant. It is not possible to relate this removal with biological processes since the Schmutzdecke layer was not developed yet. Therefore the reduction in bacterial counts must have taken place as a result of physical straining of the water through the different layers of sand in the filter. Another factor could be the natural die-off of the microorganisms in the water as a result of nutrient starvation and other factors. It would be reasonable to assume that the bacterial removal efficiency will increase with time with the formation and maturation of the Schmutzdecke layer. Unfortunately, this was not confirmed in this study due to time constraints. In terms of absolute values, the 345 coliforms per 100 ml water on the 20th day of operation shows that the water is still unsafe for direct consumption without additional treatment such as disinfection or boiling.

Reductions in BOD is essentially a biological process which involves the breakdown of complex organic substances into simple inorganic constituents by microorganisms. The 51 % BOD removal after the 20th day is most probably due largely to settling and entrapment of organic particles in the sandbed accompanied by some microbial decomposition. The soluble BOD fraction passes through the filter and may be further degraded through biological action when the sand bed becomes matured. Nonetheless, the 0.48 mg/l BOD in the treated water is within the limits set for drinking water quality.

The solids removal closely paralleled the reductions in turbidity. The 89% and 83% reductions in the solids and turbidity levels

Table 2 : SSF Removal Efficiency After 10 Days Operation.

Parameter	Unit	Raw Water	Treated Water	Removal (%)
Coliforms	/100 ml	10,859	645	94.0
BOD5	mg/l	1.2	0.6	52.2
Turbidity	FTU	15	3	80.0
Total Solids	mg/l	250.5	31.3	87.5
Hardness	mg/l	95.8	43.8	54.3
Nitrate N	mg/l	0.3	0.25	19.3
Total Iron	mg/l	0.75	0.15	80.0
Total Lead	mg/l	0.03	0.02	33.3
Total Arsenic	mg/l	0.01	0.01	-
pH		6.85	6.70	-

Table 3 : SSF Removal Efficiency After 20 Days Operation.

Parameter	Unit	Raw Water	Treated Water	Removal (%)
Coliforms	/100 ml	9.755	345	96.5
BOD5	mg/l	0.98	0.48	51.0
Turbidity	FTU	14	3	82.8
Total Solids	mg/l	278.8	30.5	89.1
Hardness	mg/l	89.5	42.3	52.7
Nitrate N	mg/l	0.3	0.25	16.6
Total Iron	mg/l	0.85	0.15	82.4
Total Lead	mg/l	0.03	0.02	33.3
Total Arsenic	mg/l	0.01	0.01	-
pH		6.85	6.75	-

respectively on the 20th day indicates that the sand size used in the sand layers in the SSF is sufficient to trap suspended and turbid matter from the water. These solids are removed principally by straining and other transport and attachment mechanisms operating in the filter.

Removal of nitrate-nitrogen was negligible. Nitrates may be removed by adsorption and biochemical processes, but in this "young" filter, the former is probably more pronounced. On the other hand, nitrate is also the end product of the breakdown of nitrogenous organic compounds. Nitrate removal did not change appreciably after the longer operation but it can be expected to increase as the filter becomes more matured.

Metals removal ranges from 28 to 33% for arsenic, 33% for lead and 80 to 82% for iron. The high removal for the total iron concentration in the water may be attributed to the nature of the crystalline quartz sand particles which has an overall negative charge and is thus able to attract positively charged particles of colloidal matter (such as crystals of carbonates and flocculi of iron and alluminium hydroxide) as well as cations of iron, manganese, alluminium and other metals. For iron, the removal efficiency increased to 82.4%. This is due to the continuing process of charge reversal (Ref. 5). In this process the sand with the negative charge attracts the iron and when saturation occurs, anions are attracted. This reversal of charge continues throughout the life of the filter once started. The exact mechanisms for the removal of the heavy metals is not well understood.

Comparison of the quality of the treated water from the 20 day old filter with the WHO guideline values for drinking water quality shows that the water is still "unsafe" for direct human consumption. This is because the presence of high coliform counts also implies the probable presence of pathogenic organisms in the treated water. In a conventional SSF water treatment plant it is well known that the efficiency of removal of bacteria, viruses and dissolved organics is very high, frequently reaching 100%. In an efficiently operated plant, more than 95% of samples taken over regular time intervals show negative results for coliforms. This efficiency is attributed to the development of the Schmutzdecke layer on top of the sand filter. Therefore it is fair to assume that the model SSF module will be able to remove bacteria more efficiently as it matures. The exact time required for this "maturation" to occur will depend on the microbial flora in the raw water and will be determined in later trials in the field. In the preliminary trials of the SSF module, the low filtration rates probably restricted the supply of oxygen and nutrients thus slowing down the rate of formation of the Schmutzdecke layer. Another factor which could have contributed towards the high bacterial counts in the treated water is the depth of sand in the filter. According to the literature, the minimum sand depth should be 50 cm and 60 cm is necessary to ensure the removal of all viruses together with complete oxidation of ammonia. However, the sand depth in this SSF module was only 20 cm. It would also be interesting to observe the effect of accumulating concentrations of metals on the microbial flora in the Schmutzdecke layer in a matured filter.

CONCLUSIONS

1. Disused mining pool water has a potential as a water resource since they do not contain excessive amounts of impurities and provided suitable treatment systems can be made available. Initial raw water turbidity values do not seem to be a problem.

2. The trial household SSF module has a high potential to treat raw mining pool water into

potable water but further studies are needed to determine the period required for it to reach maturity and the ensuing water quality.

3. In describing the results of experimentation involving raw and drinking water, absolute values should be reported together with percentage removal efficiencies. Although high percentage removals (> 99%) may be reported, they create a false sense of confidence especially when high initial concentrations of pollutants are involved.

RECOMMENDATIONS

1. The SSF module need to be run for longer periods to examine the development of the biological active layer on top of the sand bed.

2. Different sand depths should be tested to achieve a more complete removal of pollutants and also to balance with costs factors.

3. To assist the removal of metals, the use of a pre-filter such as a crushed heated charcoal bed should be considered. It can be incorporated on top of or at the bottom of the sand bed or in a separate module altogether.

4. For field applications, a number of SSF units could be assembled and fed continuously using a diesel operated pump. The treated water could be stored collectively for distribution to several households. Multiple filtration units helps to save costs and also has the advantage that when one unit is out of order, it will not cause a disruption in supplies. The SSF can also be used to treat other sources of raw water e.g. rain water, well water, etc.

5. Finally, proper sanitation practices must be adopted to prevent gross pollution of the mining pools by sewage.

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14th WEDC Conference

Water and urban services In Asia and the Pacific

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Assessment of leakages and wastages

Avadhesh Kumar and G V Abhyankar

Industrialisation and job opportunities have created a tendency in rural population to migrate in large numbers to urban areas. When the cities and towns develop and expand at high rates, existing urban services tend to be constantly under strain. In Indian urban centres increase in water demand is therefore overtaking the augmentation projects. In fact many urban water supply augmentation projects are required to be designed so as to maintain at least the existing level of services rather than improve upon the service levels for want of adequate funds. Water as source for drinking water is also getting scarcer with additional demands for irrigation from available sources.

SOCIAL HABITS & CAPITAL & OPERATING COSTS OF WATER PROJECTS

2. Due to intermittent supply systems people do not always close water taps and there is considerable wastage at public standposts and elsewhere. The cost of augmentation projects are soaring thus making it difficult to implement projects and in reasonable time. In India the elecric energy rates have gone up from 5 US $ to 75 US $ per thousand KWh in the last fifteen years. The cost of water is increasing due to increase in power tariff without corresponding increase in water charges, this further enhances the need for conservation. It has been demonstrated that it is far more economical to conserve water (upto certain minimum limit) than implementing new projects yielding equivalent additional quantity of water.

3. In many Indian cities the distribution systems are over 50 years old. The pipes are quite often corroded and broken. In such cases appreciable increase in supply quantity would not reach the consumer while the leakage losses would increase. Thus implementation of augmentation projects without controlling leakages would tend to become counter-productive. Controlling leakages is necessary as a part of routine preventive maintenance.

POLLUTION IN INTERMITTENT SUPPLIES

4. Water supply is intermittent practically in all the Indian cities. The mains remain empty over long periods every day. When the water supply is not 'on' the outside waste water tends to enter into the pipes through broken pipes and leaking joints, thus polluting the filtered water supplies, making it unsafe for drinking. By controlling leakages, such entry points for waste water are minimised reducing the possibility of the contamination of water.

MANAGEMENT OF WATER DISTRIBUTION SYSTEMS

5. One of the pre-requisites for efficient management of water distribution systems is to have accurate and updated system records. Unfortunately such records are not always available in many of the Indian cities. As a part of leakage control programmes all system data has to be in the form of drawings and reports so that it can be referred by others for better organisation and management.

6. It has been found from case studies that after an area is tackled for leak detection and repairs, the pressures in the distribution system improve, leading to better consumer satisfaction.

7. Some of the problems faced by many urban water authorities of clandestine connections, faulty water meters, leaking disconnected service pipes and inadvertantly closed valves get attended to during systematic efforts for controlling leakages.

METHODOLOGIES AVAILABLE FOR LEAK DETECTION

8. The approaches for leak detection are necessarily different for continuous and intermittent supply systems and are discussed below.

Continuous supply system

9. The probability of appreciable water lost due to leakage varies proportionately with the ratio of minimum night flow and total quantity used. Effort is therefore made to identify the areas of high night flows and concentrate leak detection work in such areas.

10. Zonal flow measurements are also useful as these provide guidance for future preventive work. Comparisons of remeasurements with previous figures provide useful information as to the probability of water lost due to leakage.

11. Detailed study has to be carried out in areas showing unexplained high night

consumption rates. This is done by subdivision of the area and measuring of the water consumption rate in stretches of the distribution piping between valves. These individual night rates of consumption must total upon the measured night rate for the zone as a whole. The areas showing excessive meter readings are investigated further to pinpoint the leaks with the help of sounding rods, electronic leak locators etc.

Intermittent supply system

12. The flow measurements during supply hours do not help to identify leakage in intermittent supply systems. The identification of areas for detailed investigation is much more cumbersome. A method which has been found useful for intermittent supply systems is as follows. A byepass arrangement is made to divert water to a zone to be tested. On the day of testing a zone for leakages, all the consumer connections in the zone are cut off as soon as the normal supply hours are over. The zone is isolated by closing all the boundary valves. Special supply is drawn and all the mains are charged with water till sufficient pressures are developed at remote ends of the zone, which is ascertained by fixing pressure gauges. Valves on fire hydrants in the zone are opened to allow the air in the mains to escape. Sluice valve on the main feeder is then closed and bypass opened. The consistent recorded flow in the meter indicates the leakage quantum in the zone. If this is excessive, step test is carried out wherein distributory mains are shut off one by one starting from remote end of the zone. Reduction of flow at each step indicates leakage in the last isolated main. The work of pinpointing the locations of leak points on the mains is done with sounding rods and electronic leak locators in the sections where leakages are high.

13. On completion of the test, special supply is closed and all the consumer connections are restored. This is completed before beginning of normal supply hours to the zone. All the boundary valves are opened and normal supply conditions restored.

14. During subsequent days all the leak points are repaired. Similar test is repeated and leakage is measured. If the leakage has come down within reasonable limits the work is stopped, or else the work is continued. At the end of tests the pressures in the zone are studied to observe the extent of improvement.

DIFFICULTIES GENERALLY ENCOUNTERED IN INTERMITTENT SUPPLY SYSTEM

15. In intermittent supply system special supply from nearby reservoir or transmission mains is required to be supplied even to remote areas in a water distribution zone, for leak detection by stop-tap method. This poses considerable difficulties. Sometimes, large number of valve operations are required to be done enroute to the area. Moreover if these valves have not been operated for long periods there is every likelihood that these require maintenance and repairs before the test. Isolation of area comprising of 250 to 300 service connections is sometimes difficult for leakage assessment as appurtenances such as on-line valves and fire hydrants may not be available at proper locations. Valves may have to be provided in the zone at certain locations for carrying out the test.

16. Passage of water past boundary valves into adjoining areas could vitiate the results of tests specially when the pressures on two sides of the valves are quite different.

17. Thefts of stop-taps is a general complaint, and therefore in some areas it is preferred to cut the pipes at the connection's end and provide a plug. The connection has to be restored quickly after the test, before the supply time for the area begins. This appreciably increases the effort and cost.

A CASE STUDY : BACKGROUND

18. Jamshedpur is one of the leading industrial towns in India. Its population in 1986 was 0.52 million and covered an area of 46 sq.km. There are about 30,000 consumer connections and only 10% connections are metered. There are about 800 standposts in the system.

Distribution system

19. The town is divided into six water distribution zones. The distribution system is mainly dead end type. Most of the pipes are 35 to 40 years old. CI pipes are used for distribution system however few stretches are of hume steel and RCC pipes.

20. The supply to the town is given three times a day (morning, afternoon & evening) each time the duration of supply is about two hours. The Stop Tap Method was adopted for leak detection in this intermittent supply system.

Preparatory work

21. One leak detection zone (LD zone) was selected covering about 100 houses in each water distribution zone for carrying out leak detection test. Aspects such as feasibility of isolation of this area from other areas, conversion to tree type system, feasibility of giving special supply were taken into account while selecting the LD zone.

22. The distribution system details of the zone where the test was to be conducted

TABLE - 1

STATUS OF PLUMBING FIXTURES OBSERVED PRIOR TO L.D. TESTS

Sr. No.	L D Zone	No. of houses covered	Approx. no. of taps	No. of float valves attended	Leaking taps replaced/ repaired
1.	Sidhgora, Tatanagar	121	350	NO OHTS	78
2.	B H Area, Kadma	117	450	46	52
3.	Bina Road/Mona Road, Burma Mines	152	450	70	49
4.	South Park, Central	82	300	46	55
5.	Vellor Road/Birupa Road, Sakchi	135	400	41	29
6.	'E' Sector, Sonary	66	300	*	*
	TOTAL	673	2256	203	263

* 60% Float valves unsatisfactory, leaking tap survey not carried out.

were studied. Alignment of the mains and location of valves were noted with the help of operating staff. The drawing showing details of the distribution mains was prepared. Various valves and other appurtenances in this LD zone were surveyed and repaired. Sluice chambers which were found buried were exposed and raised upto the road surface. All the consumer connections/house taps were surveyed and repairs carried out wherever necessary. The boundary valves i.e. the valves separating adjacent area from the LD zone to be tested were checked for passing of water and made water tight as far as practicable. Operations necessary for isolating the LD zone and for drawing special supply for testing were identified. All the valve operations required for successively isolating the distribution mains for the step-test were also identified. Normal pressures in the zone at two to three points were measured and recorded. The daily consumption pattern in the zone was assessed from the water meters fixed on the connections of few sample houses or from the available meter records. From this the daily consumption of the LD zone was assessed. By-pass arrangement with flow meter (25 mm or 50 mm size) was assembled and its fitting points were identified on the field.

23. Before carrying out LD test, each LD zone was surveyed to check leaking taps and float valves of the overhead head tanks. It was found that out of 673 houses surveyed, about 30% houses had faulty ball valves and about 12% taps were leaking. (Ref. Table 1). These were all repaired before the tests.

FINDINGS OF SAMPLE SURVEYS

24. The details of the LD zones and result of sample survey are shown in Table-2. It could be seen from the table that the leakage varied between 10% & 23% (except in Kadma LD zone where leakage was insignificant) the average being about 15%. It may be noted here that before the leakage assessment test a thorough inspection of plumbing fixtures and ball valves of the over head tanks was carried out and all these were put in order (Except in Sonary zone). Thus the losses on account of wastages in the house were substantially reduced and therefore the losses indicated by the tests can be attributed mostly to the leakage from the underground piping system.

25. A leakage loss to an extent of 15% of daily supply would normally be considered reasonable under continuous supply conditions. However, with prevailing short hours of supply in Jamshedpur leakage losses of the order of 15% are relatively high.

TABLE - 2

SUMMARY OF LEAKAGE ASSESSMENT TESTS

Sr. No.	LD Zone & W D Zone	TEST DATA					Leakage Flow rate (1pm)	Approx Leakage (%)
		No. of Houses	Population	Normal supply hours	Estimated per capita (1pcd)	Normal flow (Mld)		
1	2	3	4	5	6	7	8	9
1.	Sidhgora, Tatanagar	121	726	7.25	310	517	147.0	22.1
2.	B H Area, Kadma	117	585	5.0	180	351	3.5	1.3
3.	Bina Road/Mona Road, Burma Mines	152	912	7.0	220	478	60.0	11.1
4.	South Park,Central	82	574	6.0	200	319	55.0	14.7
5.	Vellor Road/Birupa Road, Sakchi	135	1080	6.0	245	735	110.0	13.0
6.	E.Sector, Sonary	66	400	6.0	201	223	47.0	17.4

Note : 1. Normal flow rate (Col.7) = (Col.4 x Col.6)/Col.5 x 60)

2. Leakage (Col.9) = (Col.8 x 100)/Col.8 + Col.7)

3. Contamination of filtered water was reported in LD zones at Sr.No.1,4,5 & 6.

4. 1 Liter = 0.22 Imperial Gallons.

CONCLUSION

26. The Stop Tap method for intermittent supply system can be successfully employed for assessment of leakage, though it is cumbersome in comparison to methods available for leakage assessment in continuous water supply systems. Locating the leakages and the repairs of fitting and fixtures should be given due importance to reduce wastages in the water supplies.

14th WEDC Conference

Water and urban services in Asia and the Pacific

Kuala Lumpur 1988

Provincial waterworks authority Thailand

Lawrence F Philpott

INTRODUCTION

1. In 1979 the Government of Thailand created a new state enterprise, the Provincial Waterworks Authority (PWA), responsible for the supply of water in most urban areas outside Bangkok. In 1982, with funding from Deutsche Gesellschaft Fur Technische Zusammenarbeit(GTZ), GmbH, the Authority appointed Coopers & Lybrand as its consultants on the Management and Finance Project (MFP). The project, which is still continuing, is one of the largest and most comprehensive institutional development projects ever undertaken in the water sector.

2. The improvements in the PWA's performance have been impressive. An operating loss of 38 million Baht in 1982 became an operating surplus of 188 million Baht in 1986. Between 1982 and 1986 the volumes of water produced and of water sold rose by, respectively, 22% and 25%. The number of employees fell from 15.47 per thousand connections to 11.71 and the number of connections increased by 31% from 333,000 to 437,500. The Thai Government has embarked on a programme to ensure that public enterprises meet operating requirements without Government financed subsidy. The PWA is one of the first public enterprises to meet this requirement.

3. The PWA is now regarded by the Government as a 'model public enterprise' and is used for management study tours by other organisations in the Thai public sector. The public and press have more favourable attitude towards its performance. The Authority is more attractive to international aid and lending agencies and development programmes are now underway involving, for example, the World Bank, KfW, the ODA, JICA and UNDP, as well as GTZ.

4. The purpose of this paper is to focus on the contribution to the institutional development process made by the PWA's Training Centre and specifically the methodology which was used to identify, on a systematic and objective basis, the training needs of the 1,300 headquarters and regional staff in the PWA.

Tasks and Skills Analysis

5. Because the PWA had no system of staff performance appraisal there was no regular, systematic assessment of the training, education and development needs of individual members of staff. It was therefore decided to remedy this by commissioning a tasks and skills analysis exercise to be undertaken jointly by the PWA's Training Centre and line managers. The remainder of this paper sets out the principles of the exercise and its results as follows:-

(a) objectives
(b) procedures
(c) analysis and findings

6. The objectives of the exercise were contained in the terms of reference which required us to:-

"Carry out tasks analysis and prepare a skills inventory for defining training needs in the areas of supervision, management and technical skills at PWA Headquarters and Regional Offices".

7. The objective was to define, by a process of tasks and skills analysis, the training gap, ie. the difference between the level of skills required in each job compared with the level of skill possessed by each postholder. The information produced by the analysis would therefore show the training needed by each postholder and, when aggregated, the overall size of the training task for various groups of staff. It also enabled training priorities to be assessed because the approach adopted included provision for line managers/ supervisors to indicate their views on where the priorities for training lay.

8. Procedures for the exercise were centred on a data collection form which is set out at the end of this paper. Ths form was in the Thai language. In summary the process of tasks and skills analysis was as follows:-

(a) a team of PWA analysts was briefed about the technique;
(b) for each post details of:-
    (i) analyst name
    (ii) post title
    (iii) post grade
    (iv) department/region
    (v) division
    (vi) section

were entered on data collection forms by the analysts:
(c) brief summaries of the duties and tasks of each job were entered onto each form by the analysts. Job descriptions were used for this purpose; where job descriptions did not exist, duties and tasks information was obtained through discussions between the analysts and line managers/supervisors;
(d) factfinding discussions were held with line managers/supervisors to:-

(i) agree the "duties and tasks" information on the form ;

(ii) establish details of the minimum levels of education and experience required for each post;

(iii) establish details of the skills and knowledge required to carry out the agreed duties and tasks including, where appropriate, basic, middle or advanced management skills;

(iv) establish any special job-related requirements, which were then entered in the "additional comments" box on the form;

(v) establish the number of staff working in each particular job and enter this information on the form;

(e) each data collection form was photocopied (one for each postholder in each job) and the copies returned to the line managers/supervisors of functons so that they could enter the following on each individual form:-

(i) the name of the postholder;

(ii) details of the education level and experience of the postholder;

(iii) a mark in the "performance satisfactory" or "more training needed" box depending on the line manager/supervisor's view of the performance of the individual concerned;

(iv) a priority rating (described below) for the areas where more training was needed;

(v) an indication of whether the postholder needed training in basic, middle or advanced management training skills. Background briefing notes on these three management training levels were provided to help managers/supervisors. Finally, managers/supervisors were given the opportunity to enter on the form any special comments relating to training needs.

(9) As mentioned above, the system of data collection incorporated a mechanism to allow line managers/supervisors to indicate the priorities attaching to the training needs of their staff. The priority ratings used were as follows:-

Priority Rating By Line Manager	Analysis
1, 2 or 3	High priority; training required as soon as possible.
4, 5 or 6	Medium priority; training required in the medium term.
7 and above	Low priority; training to be provided in the longer term.

(10) From the completed sets of forms for each post the analysts then completed a summary of the training needs on a further form showing:-

(a) the skills (training) required, in priority rating order;

(b) the number of staff requiring training; and

(c) the number of staff whose level of education/experience was below that required for their post.

(11) The analysis and findings covered a total of some 200 different types of post (in headquarters and regions) and the following analyses were produced:-

(a) for each headquarters division, details of the training subjects (skills) required, the numbers of staff requiring them and the priority ranking attaching to the training (ie. short, medium or long term);

(b) for each of the regions, an analysis similar to that referred to above;

(c) an analysis of the twenty training subjects (skills) most urgently needed in the short term in headquarters' departments;

(d) an analysis similar to that referred to in (c) above for each of the regions returning data; and

(e) an analysis of (c) and (d) above showing the twenty most urgently needed training subjects (skills) in headquarters and regions.

In this way line managers/supervisors and Training Centre management were provided jointly with a wide range of quantified information on the training required in the PWA ranked in order of priority.

12. The benefits of the exercise can be summarised as follows:-

(a) the tasks and skills analysis output provided the foundation for a regular staff performance appraisal system to be installed by the PWA;
(b) basic training records were established for each person covered by the analysis;
(c) the output of the exercise provided a sound basis for the development of training plans, programmes and courses to be established jointly by line managers/supervisors and the Training Centre;
(d) the effectiveness of the training to be provided could be judged against agreed training objectives.

13. It is interesting to note that the top ten subjects where significant amounts of training

were required were, in order of priority, basic management skills, training skills, operations and production system management, technical English, computer application skills, accounting systems' skills, statistics and data evaluation techniques, budgeting, project preparation, development and communications skills.

14. Further information on successful, practical application of this systematic approach to the tasks and skills analysis process, closely involving line managers, are available from the author on request.

PROVINCIAL WATERWORKS AUTHORITY OF THAILAND: TASKS AND SKILLS ANALYSIS

Analyst name	
Date of interview	

Form number		

Post title	Name of postholder
Grade	
Education level/ Experience required for post	
Education level/ Experience of post-holder	

Department/Region			
Division			
Section			
Manager/Supervisor		Date of appraisal by manager/supervisor	

Main duties and tasks	Skills and knowledge required	Performance satisfactory ✓	More training needed ✓	Priority
	Basic management skills			
	Middle management skills			
	Advanced management skills			

Additional comments (if any) from analyst	Additional comments (if any) from manager/supervisor

SESSION I
WATER SUPPLY

Chairman: Professor John Pickford
WEDC
Loughborough University of Technology

PAPERS PRESENTED

E R NICHOL
Rural water supply - W Timor, Indonesia

G GHOSH
Management of drinking water in drought

MOHAMMAD ISMAIL YAZIZ and OMAR DIN
Portable slow sand filter performance

A KUMAR and G V ABHYANKAR
Assessment of leakages and wastages

L F PHILPOTT
Provincial waterworks authority, Thailand

DISCUSSION

E R NICHOL

1. Dr AKALLAL asked what was the life expectancy of the small dams with regard to erosion and the intensity of rainfall. Who was responsible for the maintenance of the dams and what were the reasons for some of them being unsuccessful?

2. Mr NICHOL replied that the life of the dams was recognised as being finite but unknown. It was dependent on the pasture state in the catchment. Legume pasture species were sown along contours to improve soil, reduce soil erosion and increase the life of the dam. Maintenance was in the hands of the Jaya Air (the water watchman) who referred problems to an institutional umbrella, eg public works and forestry departments when dealing with water supply. The reason some of the dams failed was because they were built of limestone soils to prove they would leak, as an example of the wrong material siting. One dam catchment yield was considerably less than expected. This was a limestone catchment with high infiltration so the dam had not filled.

3. Dr BELL asked about the residual water from washing being used for garden cultivation. Was there an indigenous system of such cultivation; what crops were grown and were they used for domestic consumption and/or for sale.

4. Mr NICHOL explained that there was no supplementary watering of gardens. The crops that were tried were various species of beans, tomatoes, carrots and lettuces. Initially, as the village people had no awareness of taste for these crops, they were sold to passing traffic. However, subsequently there was an increase in local consumption.

5. Dr KOOTTATEP asked who was in charge of the management of the dam and how could they ensure equal supplies of water to the villages and individual farmers. He was concerned that those who lived near the dam would get more benefit from it than those who lived further downstream and this would create conflict among the villagers.

6. Mr NICHOL explained that the outlet tanks supplied from the dams had been sited a "reasonable" distance from the village, so that water carrying by the women (a village social occupation) was maintained, but reduced in distance and time. All dams and catchments were fenced off to prevent access to animals, reduce access to humans and ensure that catchment conditions did not deteriorate as contour pasture improvement was undertaken in each catchment. There was an overall institutional management structure for which the Jaya Air was responsible. The Jaya Air was elected by the village group and trained by this project management structure.

7. Dr SRIVASTAVA wished to know the catchment yield during scarcity periods in the dams.

8. Mr NICHOL said that the endeavour was always to balance the annual catchment yield to storage volume. The yield is a function of a number of variables, catchment area and soil type being two of the most important. Initial indications on the Bobanaro clay land systems indicated a yield of 1.0-1.2 Ml/ha/year. A land unit assessment for West Timor had identified land units with suitable material and reasonable slopes that had potential as earth dam sites.

G GHOSH

1. Mr ABHYANKAR commented that with the increase in the standard of living, especially in the cities, the per capita demands for water were increasing and were well over the 140 lpcd mentioned by the author. He asked Mr GHOSH if he could enlighten him on the Government of India's policy in clearing augmentation of urban water supply projects for increasing the supply beyond 140 lpcd, which was quite expensive.

2. Mr GHOSH said that there could be no standard policy. If the source permitted and the community was prepared to pay then the water supply could be augmented. Nowhere in India was 140 lpcd maintained, not even in large cities. Nearly 30%, or more, of the urban population are 'floating'. They were not taken into consideration for calculation of per capita water supply. Expensive schemes should be fully discouraged. This was obvious from the fact that Delhi, Calcutta and other cities were augmenting their water supply through digging deep boreholes which also reduced the cost of filtration/treatment of water.

3. Dr BRADLEY asked what defluoridization systems were adopted in the home and how were they monitored. Was there a feed back system to check the chemical use and what was its effectiveness?

4. Mr GHOSH explained that it was called 'Nalgonda Technique' developed by NEERI (National Environmental Engineering Research Institute, Nagpur). Simple lime and alum were used for treating the water; after standing for some time it was decanted to remove the slurry. Domestic users were encouraged to do this until safe water could be supplied. Camps were organized to motivate village level workers, medics and para-medics and they in turn taught the villagers. A check of the teeth of school children was the easiest and simplest method of detection of fluorosis.

5. Dr BRADLEY also wanted to know what was the most successful (technically and cost effective) iron removal system in India.

6. Mr GHOSH said it was an oxidation process, also developed by NEERI. DANIDA had used one modification in Orissa. However, presence of carbon dioxide affected the process. Along with iron, carbon dioxide must be estimated for the treatment package.

7. Mr LANE asked to what extent the project attempted to direct or advise NGOs on their activities, as they tended to exhibit a wide range of approaches.

8. Mr GHOSH replied that the first priority was to tap those NGOs who were already in the field of RDWS. Some of them were also being used for communication only. Some NGOs working in sanitation and health were also used for follow-up action and health awareness programmes. NAWDA had arranged it.

9. Mr LANE commented that Mr GHOSH had mentioned CAPART and wanted to know if Mr GHOSH had more information about this organization. He worked for a similar organization, SSNCC, in Nepal.

10. Mr GHOSH said information about CAPART could be obtained from the Director General, Council for Advancement of People's Action in Rural Technology, Guru Narak Bhavan, Mehranti Road, near Quto Hotel, New Delhi. The Director General is Mr S M Patankar and the Deputy Director General is Mr Ashoke Jetley. He also suggested that Mr LANE might like to contact Dr M A Ghone, Secretary, National Association of Water Development Agencies (NAWDA), Shanker Shet Road, Pune, Maharashta, India.

11. Mr NEPAL asked if it was possible to lower the water demand without rationing. He said that water demand was related to living standards and facilities provided within buildings. Water demand should theoretically be kept to a minimum but practically it was the reverse and needed some sort of sewerage system.

12. Mr GHOSH replied that if in a system the supply was less than the demand then either the community distributed it equally or a group got the lion's share. In such a system the Government had to step in to fill up the gaps but this would certainly affect the sewerage system too.

13. Mr NEPAL suggested that the excessive use of groundwater might lead to permanent lowering of the groundwater table whereby making it impossible for ordinary handpumps to work. He said that last year's drought had already lowered the water table by four metres. He asked Mr GHOSH for his comments.

14. Mr GHOSH commented that only 4.6% of groundwater abstraction was used for drinking purposes. It was the excessive demand of agriculture and industry which affected the groundwater table. In a good rainfall year recharging was not a problem but it was most important to maintain the water balance. That was why the India Mark II handpump had been encouraged and not tubewells with submersible electric pumps. The sinking of tubewells in areas of water scarcity was to be controlled by legisation.

15. Dr OKOYE enquired if the Government of India had considered a user charge and community participation (in cash and kind) in their current water project/programme.

16. Mr GHOSH said that at this stage they had not but under the present programme if a piped water supply was provided a charge was made. Under the first programme, provision of safe drinking water was the responsibility of the Government, but the maintenance of the system was the responsibility of the local community. Community participation at this stage was thought of in the form of kind, in some cases by money.

MOHAMMAD ISMAIL YAZIZ

1. Mr KOLSKY asked for additional information on the performance of the filter on less polluted water, as the bacterial contamination of the reported raw water was very high.

2. Dr MOHAMMAD explained that the SSF used in this study was relatively immature, ie the Schmutzdecke layer had not developed even after twenty days. The data for bacterial removal efficiencies (94-97%) were more the result of physical straining and other physical forces than biological degradation. At this stage adequate data were not available on SSF efficiency for cleaner water sources (eg rainwater); nonetheless it was anticipated that a mature SSF would be able to remove bacterial contamination in cleaner waters as well as grossly contaminated waters.

3. Mr HUTTON commented that short circuiting on tanks could lead to loss of efficiency and asked if this had been considered.

4. Dr MOHAMMAD thanked Mr HUTTON for his comment and said this had not been considered but that it would be in future studies.

5. Dr OKOYE stated that experiments carried out in Corvallis, Oregan, USA, using the SSF approach presented by the speaker, showed that over a one-year period Schmtzdecke formation took twenty-one days to mature and only then could the SSF function efficiently. Influent water was taken from a stream with low microbial flora. It took three months to get the SSF to function without a breakdown occurring as a result of many factors such as plugged valve, silt accummulation and pump breakdown.

6. Dr MOHAMMAD said that in the literature the times quoted for the development of the Schmutzdecke layer ranged from twenty to ninety days. In some cases shorter periods were obtained through the use of seed material. It was difficult to place a fixed value on the time required since a great deal depended on the actual quality of the raw water used. In this study, using mining pool water abstracted one-third of a metre below the surface and four metres from the bank, no significant development of the Schmutzdecke was found after twenty days.

G V ABHYANKAR

1. Mr SALAMAT WAHIF asked if the percentage of leakage due to inaccuracy or under-registration of water meters had been evaluated. If so how much did it contribute to the total leakage level. He commented that proper management and maintenance of water meters would reduce the leakage due to under-registration of the meters.

2. Mr ABHYANKAR explained that loss due to under-registration of the meters would not be a leakage loss but a revenue loss so it would not affect the leakage levels. In the case study presented he said the aspect of meter inaccuracies had not been covered. Moreover, only 10% of comsumer connections were metered in Jamshedpur.

3. Mr RICHARDSON asked if any attempt had been made to link the leakages recorded with the pressures which pertained at the time of the measurements in order to assess what could have been leakage levels under higher and more normal pressures. He commented that the estimated per capita consumption figures in column 6 Table 2 seemed very high when compared with figures quoted on Indian consumption levels by other speakers in Session 1.

4. Mr ABHYANKAR replied that in this case study relationships between pressures and leakage levels had not been assessed. He said the estimated per capita consumptions were based on metered consumption in a few houses in each test zone and were therefore likely to be close to reality. The overall gross per capita supply in the city was also high, around 250 litres per day.

L F PHILPOTT

1. Dr BRADLEY asked when the needs assessment was carried out in the project cycle. Was it found necessary to first establish performance indicators. Was there a tendency for training to be viewed as a "perk", particularly for training venues overseas and in main cities.

2. Mr PHILPOTT explained that the training needs assessment was undertaken two years into the project cycle, after a thorough review of the PWA's organisation and management systems had been undertaken and the subsequent process of change was underway. Part of the organisation review, along with the wide range of other work being undertaken, was the establishment of a series of performance indicators against which organisational performance could be measured. Training could sometimes be viewed as a "perk", particularly for training venues overseas and in main cities. As long as such training was effective in its own right, and was complemented by effective training provided locally, overseas training could be viewed as a logical incentive to be offered to those who would benefit from it.

3. Mr GHOSH wished to know the content of the training. He suggested that operators could be the best carriers of messages of health. He asked Mr PHILPOTT for his opinion.

4. Mr PHILPOTT replied that the content of the training provided by the PWA related to a wide range of jobs in PWA headquarters and the ten PWA regions. Essentially, the training was practically based, wide ranging in terms of technical and management skills and was dedicated to improving the level of knowledge and skills of postholders. Messages for health were important and should be included in training modules provided for staff who have direct customer contact.

5. Mr GHOSH asked how the low level staff were motivated.

6. Mr PHILPOTT said that the motivation of lower level staff was important and the driving force for this should come from first line supervisors and, in turn, line managers. The commitment of line managers and their involvement in training is central to this process. Lower level staff would regard their jobs as valuable only if their line managers demonstrated that they recognised this value. It was important for line managers to have close and regular contact with lower level staff and to ensure that the staff were informed on a regular basis about what was going on. There were a number of well-tested mechanisms for doing this, including news-sheets. Equally, lower level staff should be given an opportunity, perhaps through briefing groups and/or quality circles, of making a contribution towards organisational improvement. Staff rotation between jobs and job restructuring/enrichment programmes were a further method of motivating lower level staff. Finally, staff at all levels must be given a career structure, which, if they took advantage of it, provided opportunities for advancement.

7. Dr KOOTTATEP commented that in his opinion PWA have their own problems of staff knowledge and a number of problems of having the wrong man on the wrong job. This could be solved by their own management and things could be put right. He wondered whether any training programme would solve the problems.

8. Mr PHILPOTT stated that training should be made available to improve individual/group job performance. In addition, where it was necessary for individual members of staff to move from one job to another, training should be made available to help the jobholder to acquire the new knowledge and skills which are required. In a large organisation such as PWA with 5000 employees, the process of identifying, establishing and implementing a comprehensive training programme was, of necessity, a relatively long term one. This emphasised the need to approach the identification of training needs in a systematic way so that training priorities could be established and management helped to direct resources to the most appropriate parts of the organisation.

9. Mr MUELLER asked if a part privatization of the Provincial Waterworks might help to overcome the difficulties and improve the service to end consumers.

10. Mr PHILPOTT replied that privatisation of parts of a water utility could help to improve service to consumers provided the objectives of privatisation were identified at the outset, the appropriate privatisation "model" was chosen and the process of privatisation was carried out effectively. His experience had reinforced the conclusion that there is no universally "correct" way of organising water supply services. Different cultures, economies and development objectives are among the factors which impact on this. In general, however, a form of "corporate" model for a water supply organisation was likely to be more appropriate than the "government department" model since the former encouraged a more objective-orientated approach and freed the organisation from day-to-day detailed controls which may have inhibited its ability to provide the required level to its customers and make an appropriate charge. Within a corporate framework it was then often advantageous to "privatise" at least some of the activities which were carried out. By this means it may be possible to bring in private sector skills which would otherwise not be available to a public sector organisation and improve the effectiveness and efficiency of the services provided.

11. Mr RICHARDSON, taking up an earlier point, said that he had found in his work for PWA in Chonburi in 1986, that the PWA-public contact point focussed on low grade employees such as meter readers and bill collectors. He commented that these appeared to have been given an absolute minimum of training and had not been made to realise, nor given credit for the importance of, their ambassadorial role. An example was that Chonburi meter readers were expected to spot and report a malfunctioning consumer meter, but received virtually no training to help them recognise such cases, either by direct observation or by interpolation of meter readings.

12. Mr PHILPOTT said that training in "relationships with the consumer/customer" was an important part of the training which should be provided for staff who have

customer contact. It was vital that a broad view was taken of all training needs, in the process of training needs analysis, and that activities which enhanced service to the consumer were emphasised. Typically, and understandably, water supply authorities and utilities had placed overriding importance on the need to train their employees in technical disciplines to ensure that water supply facilities were built and operated in a safe and effective way. Increasingly, however, it was recognised that training in management, finance and public relations played an equally important role in helping to meet these objectives and provide safe and secure water supplies on a long term basis.

13. Dr SRIVASTAVA asked if the keynote was the output indicator. If so, how was, say, drinking water to the end beneficiaries related to the impact of training of line managers.

14. Mr PHILPOTT replied that output indicators are initially vitally important in terms of measuring organisational performance. The provision of training was one of the methods of improving organisation performance and there was much evidence that the best organisations placed heavy emphasis on training and development. However, direct measurement of the link between training and output could only be measured in certain circumstances, eg better productivity and accuracy from staff whose job was, for example, to process financial accounts. In other instances, eg management development, quantifiable measures were much more difficult, if not impossible, to quantify in anything like a direct way. Typically, for a water supply utility, overall organisational performance measures would include, for example, the percentage of the population served with water, the volumes produced and distributed, volumes of water unaccounted for, hours of supply in a day, water quality measures, ratios of employees to connections, and financial indicators such as unit costs, billing levels and collection performance.

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Water and urban services in Asia and the Pacific

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Package treatment plant utilising RBC

Nik Fuaad Nik Abllah

ABSTRACT

In 1985, it was estimated that about 5.3 per cent of the population of Malaysia had access to centralised sewerage treatment plant. About 84.5 percent had some form of treatment while 10.2 percent had no sanitation facilities whatsoever. Especially for those in the urban or peri-urban fringes and run-down slums of large towns and cities without any proper sanitation facilities a compact package on-site domestic wastewater treatment plant could be the answer to their sanitation woes.

A full scale sewage treatment plant with primary and secondary sedimentation tanks incorporating a rotating biological contractor(RBC) as secondary treatment was employed to evaluate the process performance and to develop kinetic models when treating domestic wastewater. RBC was chosen as secondary treatment due to its carbonaceous and ammonia nitrogen removal efficiency, low power consumption, greater flexibility, low retention time, low sludge production and low mechanical maintenance requirements. The RBC was operated at different organic loading rates that ranged from 13.1 to 27.8 gCOD/m^2/d. The overall carbonaceous and ammonia nitrogen removal percentages were from 84 - 92 percent and 82 - 93 percent respectively.

Steady state kinetic models for carbonaceous removal was used to obtain the kinetic constants to be used as a design aid.

INTRODUCTION

Although the government has and will be spending large sums of money in providing piped water supply to urban and rural areas, there has not been, nor is there expected to be, a similar commitment in providing central water borne sewerage system. On-site sewage disposal system is a possible alternative but is generally ineffective usually because of poor design and inadequate maintenance. The answer to this problem could possibly be to advocate the use of more effective secondary biological treatment systems. One such system is the rotating biological contactor.

The purpose of this investigation was to study the effectiveness of the package treatment plant and the process performance of the RBC so that kinetic contants could be obtained.

MATERIALS AND METHODS

A four stage full-scale RBC unit together with two rectangular sedimentation tanks were used in this study. The diagram of the package plant is shown in Figure 1.

PROCESS PERFORMANCE

The study was conducted at 4 different organic loading rates that ranged from 13.1 g COD/m^2/d to 27.8 g COD/m^2/d. Table 1 summarise the process performance of the plant.

The primary and final sedimentation tanks both reduced the COD of the incoming wastewater by about 19-28 per cent. In terms of suspended solids, the removal percentage was in the range 40 - 65 percent.

In the RBC, the overall removal percentage increased with increasing organic load. The overall removal percentages were 92.3, 84.2, 88.9 and 86.6 percent for organic loading rates of 27.8, 25.6, 17.6 and 13.1 respectively. More than 90 percent of the organic content of the wastewater was removed in the first stages of the RBC.

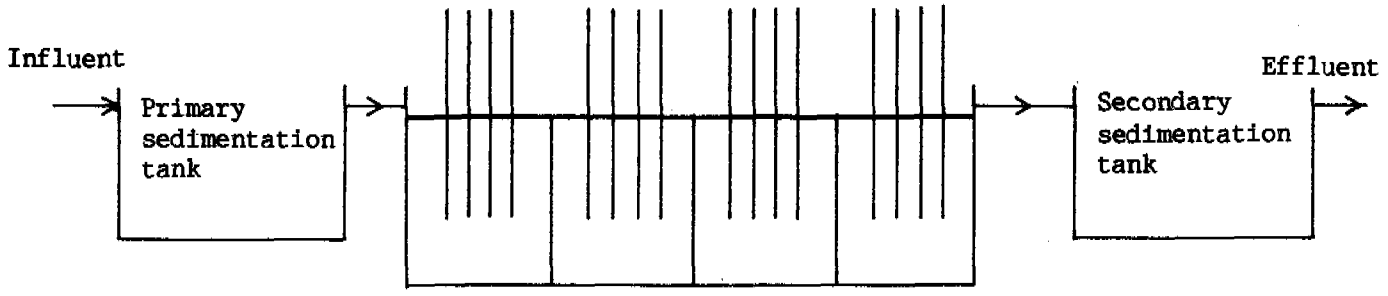
It was also observed that significant quantities of ammonia nitrogen were being converted into other forms particularly in the second and third stages. The overall ammonia-nitrogen removal percentages ranged from 85 - 95 percent for the above organic loads.

KINETIC MODEL FOR COD REMOVAL

The model developed by A. Pano (1981) was used in this study. Using the mass balances of the substrate around the attached growth and mixed liquor and by applying the total attached biomass and monod growth kinetics to the reaction rates results in the following model:-

$$[Q\,(S_o-S_1)/A_1X_1]^{-1} = \frac{K_s}{k}\,\frac{1}{S_1} + \frac{1}{k} \qquad (1)$$

where:-



Four-Stage RBC Unit

Figure 1 : On-Site Package Treatment Plant

Q - influent wastewater flow rate, m^3/d

S_o - influent substrate concentration, mg/l

S_1 - effluent substrate concentration, mg/l

A_1 - total available surface area for attached growth, m^2

$\bar{X}_1$ - attached growth per unit area, g VS/m^2

K_s - half saturation constant, mg COD/l

k - maximum reaction rate, 1/d

The kinetic constants obtained from experimental data were:-

K_s = 340.4 mg COD/l

k = 10.0 1/d

Prediction of the quantity of attached biomass uses a saturation type relationship as follows:-

$$\bar{X}_1 = \frac{k_x M_1}{K_x + M_1} \qquad (2)$$

where:-

$\bar{X}_1$ - quantity of attached biomass in the first stage, g VS/m^2

M_1 - organic load, g COD/m^2/d

K_x - constant, g COD/m^2/d

k_x - constant, g VS/m^2

TABLE 1 : Summary of Process Performance in Terms of COD

Percentage removal in primary sedimentation %	Organic load into RBC g COD/m^2/d	First stage RBC percentage removal %	Overall RBC percentage removal %	Percentage removal in final sedimentation %
28.0	27.8	85.6	92.3	24.1
26.2	25.6	81.9	84.2	21.6
22.7	17.6	88.3	88.9	18.8
22.2	13.1	84.6	86.6	19.7

From the experiemntal data, the constants were:-

K_x = 26.9 g COD/m^2/d

k_x = 54.4 g VS/m^2

KINETIC MODEL FOR AMMONIA NITROGEN REMOVAL

For the ammonia-N removal, the monod growth kinetics type of equation is as follows (Pano, 1981).

$$\left[\frac{Q(C_{i-1}-C_i)}{A_i}\right]^{-1} = \frac{K_N}{k_N}\frac{1}{C_i}+\frac{1}{k_N} \quad \ldots\ldots (3)$$

where:-

Q - influent flow rate, m^3/d

C_i - ammonia nitrogen concentration in stage i, mg/l

A_i - total available surface area per stage, m^2

k_N - ammonia nitrogen maximum reaction rate, g N/m^2/d

K_N - ammonia nitrogen removal half saturation constant, mg N/l

The kinetic constants obtained from the experimental data were:-

k_N = 6.25 g N/m^2/d

K_N = 7.41 mg N/l

CONCLUSION

The package treatment plant incorporating the RBC has demonstrated to be an efficient wastewater process in removal of biologically degradable carbonaceous compounds in a tropical environment. For design purposes, the kinetic constants determined in this paper can be used to calculate the required RBC surface area to meet prescribed effluent standards.

ACKNOWLEDGEMENTS

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Water and urban services in Asia and the Pacific

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Palm oil mill effluent treatment

R Ahmad, R Abdul Aziz and A Hussein

INTRODUCTION

Palm oil production has been known to be one of the major water pollution contributors in Malaysia. There are currently 272 palm oil mills and 36 operating refineries throughout the country (1). They produced a total of about fifteen million tonnes per anum of wastewater, most of which, finally discharged into the environment. Since rivers naturally provide convenient supply of water, many palm oil mills are located near rivers. Most of these rivers are still being used for domestic purposes, including washing and drinking.

Government concern and public awareness over the environmental effects of uncontrolled disposal of the palm oil mill effluent, has forced the industry to improve the wastewater treatment methods so as to minimise the impact of the wastewater on the environment.

RECYCLING OF PALM OIL MILL EFFLUENT (POME)

Recently, effort has been made to recycle the treated POME as process water. Such an attempt would directly reduce the amount of the POME discharged into the environment, and hopefully, would reduce the overall cost of palm pil production. In one of the mills which uses the treated effluent as process water, it was able to cut down the use of water supplied by Jabatan Bekalan Air (Water Supply Department) as much as 57% and resulting in an estimated saving of over M$40,000.00 per annum (3).

Lately it was found, however, some difficulties arose due to precipitation of soluble materials when the water, out of necessity, is heated up to about 90°C. Accumulation of the precipitate in the piping systems has forced the milling operation to be halted periodically for cleaning operations.

The fact that the recycled wastewater is still giving rise to such problems in its usage indicates that, the existing anaerobic and aerobic digestions, although they are capable of removing most of the suspended solids from the effluent, are not sufficient to recover the wastewater into near equivalent of the fresh water supply.

The recycled POME has the following characteristics:-

- contain about 2.77 g/L of suspended solids and dissolved materials,
- dark brown in colour,
- pH $\approx$ 8.0
- produces green precipitate upon heating.

Typical reuse of POME is to reduce the thickness of the extracted palm oil in order to increase the mobility of the oil during process. Considering the amount of such water that is potentially being used in the future, there is a need, therefore, for an extensive study to improve the quality of the recycled wastewater.

Since further improvements on the existing treatment methods will, inevitably, incur some extra costs of production, it is obviously desireable that any alternative or additional treatment method bears only a minimum cost. Alternatively, such a study could also lead to new findings on the nature of the waste materials and subsequently suggesting some commercial values and applications.

Taking these factors into consideration, preliminary studies have been conducted on the possibility of utilizing easily available local materials, such as peat soil, as a filtering medium for a tertiary treatment of the recycled POME.

APPLICATION OF ALUM AS COAGULATING AGENT

The application of alum, was found most convenient and effective in removing the colloidal materials from the recycled wastewater. Previous studies (2) indicated that there is an optimum quantity of the added alum which correspond to the most rapid coagulation process and the settling down of the precipitate. It was also found that, temperature has a considerable effect on the minimum amount of alum required to

produce a maximum clarity (minimum turbidity) of the treated water. Table 1 indicates that a minimum dose of alum could be employed when the wastewater is heated up to 80°C.

Table 1 The minimum dose of alum needed to give a maximum clarity of the treated wastewater a different temperatures.

Temperature °C	Dose of alum mg/L
30	1804
50	1710
60	1520
70	1235
80	571

Since the process water is normally heated up to about 90°C prior to mixing with the crude palm oil, it should be possible, during the milling process, to employ a minimum amount of alum if the addition is made somewhere between the heating of the process water and the mixing with the crude oil. (Fig. 1)

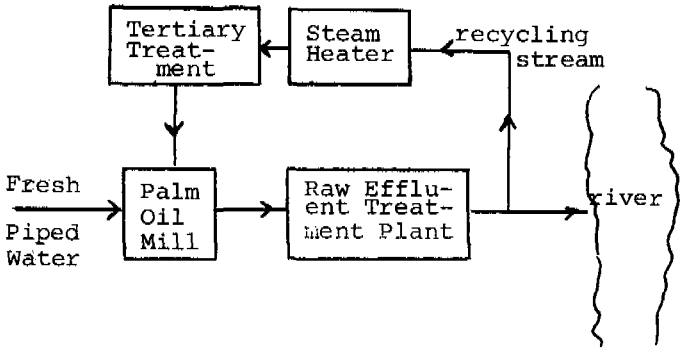

Fig. 1 : Suggested Process Flow Diagram for the Proposed Tertiary Treatment.

APPLICATION PEAT AS FILTERING MEDIUM FOR THE RECYCLED POME

A study was carried out with the aim of utilising a locally available material as a medium in the diltration system for improving further the quality of the recycled POME. In doing so, we have chosen peat soil, since it is abundantly available in various places throughout the country. The local peat was found to be a suitable filtering medium in removing heavy metals such as Cd^{2+}, Cu^{2+}, Ni^{2+}, Pb^{2+} and Zn^{2+} from aqueous solutions (4).

The use of alum was found to increase metal content (particularly aluminium) in the treated wastewater. In this preliminary investigation, a bench scale glass column was filled with a chemically modified peat and the aluminium content of the wastewater, was determined before and after passing through the column.

Table 2 Removal of Aluminium From The Wastewater After Treatment With Alum Using Peat Columns

	Fast Flow-rate	Slow Flow-rate
Flow rate (ml/min, cm^2)	50.9	1.0
Peat particle size (mm)	1.0	0.6 - 1.18
Peat quantity (gm)	10	4.0
$[Al^{3+}]$ prior to peat treatment (mg/L)	92.6	0.101
$[Al^{3+}]$ after peat treatment	85.2	0.015
Percentage of Al^{3+} removed	3.8%	85.2%

$[Al^{3+}]$ = concentration of aluminium ion in wastewater

Table 2 indicates that the metal removal efficiency by a peat column is effected by flow rate. Considering the large quantities of wastewater generated in a palm oil mill, one would like to have a fast flow filteration system. Since it is known that metal uptake by peat soil is mainly through ion exchange process, it is obvious that a longer residence time would give a more complete exchange between the metal ions and the hydrogen ions of the peat active sites.

In the present study, the half time for Al^{3+} to attain equilibrium was found to be 3.0 min. as compared to 2.2, 3.1, 10.9, 11.5 and 18.8 min for Pb^{2+}, Cu^{2+}, Zn^{2+} and Ni^{2+} respectively (4).

COMPARISON BETWEEN PEAT AND ACTIVATED CARBON

As the application of peat to the palm oil effluent treatment is a rather new area, it is desirable to compare its potential as a filteration medium with that of commercial activated carbon. Table 3 represents a comparison on the total binding capacities of Al^{3+} from the wastewater by chemically treated peat and other types of activated carbon. It is apparent that peat soil, after some chemical modifications, is capable of absorbing aluminium from an aqueous solution

almost five times better than that of the commercially available activated carbon.

Table 3 Total Binding Capacity of Al^3 by Peat and Activated Carbon

Material	Binding Capacity mg/kg
Peat	144.4
Commercial activated carbon	41.6
Activated carbon derived from coconut shell	12.5

Results also show that peat has the capability to remove colouring materials from POME, but the capability is still much to be desired when compared to the capability of activated carbon.

CONCLUSION

This study has indicated that locally available peat soil is suitable as filteration medium for palm oil mill recycled wastewater treatment. It is apparent that a longer contact time between the peat and the wastewater is preferable in removing the aluminium content of the POME after alum addition. It is also apparent that chemically modified peat soil could be a better absorbance of metals from wastewaters as compared to that of the commercial activated carbons.

It is also established that the modified peat is capable of absorbing the coloured material from the wastewater. Under the present conditions, however, its absorbing capacity is apparently less than that of the commercial activated carbon.

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Water and urban services in Asia and the Pacific

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Efficiency of oxidation ponds

Dr A Suki, H Jenny and MD Rashid

INTRODUCTION

Oxidation pond is being widely used in Malaysia in particular for the treatment of domestic wastewater in residential areas. It has been the recommended treatment method in Malaysia and is popular particularly as it is cheap, easy to construct and maintain. Eventhough its use has been quite extensive, data on its operation is limited. Available data are also rarely analysed and published.

There are numerous studies on oxidation ponds carried in other countries notably by Gloyna(1), Mara(2), Sauze(3) and Marais(4). However the results obtained have to be compared to the data obtained in Malaysia in order to determine its applicability. Work on the design and performance of oxidation pond in Malaysia have also been reported by Maheswaran et al(5) and Tan Hoo(6). Here the results of water quality, flow data and tracer experiment obtained from two oxidation ponds will be discussed.

THEORY

The aerobic biological decomposition in an oxidation pond can be described as a first order reaction such as

$$dl/dt = - k\, t \qquad (1)$$

where I is the concentration of organic matter, t is the retention time and k the rate constant. The above equation can be integrated and given in terms of y, the BOD at time t and lu, the ultimate BOD. The resultant equation is given as

$$y = lu\,(1 - e^{-kt}) \qquad (2)$$

The above mentioned equation is for the carboneceous decomposition only. However the nitrogenous demand can be incorporated if its rate constant is known.

The pond system studied can be considered as ideal reactors such as a plugflow (PF) reactor or as a completely mixed flow reactor (CMF). From material balance and using first order kinetics the relevent equations are as follows;

$$\text{PF} \qquad le / lo = e^{-kt} \qquad (3)$$

$$\text{CMF} \qquad le / lo = 1/(1 + kt/m)^{m} \qquad (4)$$

where lo and le are the organic concentration at the influent and effluent of the pond respectively. The number of stages for the CMF reactor is denoted by m.

The time refered to in the above equations is the mean retention time. This is normally obtained using the hydraulic retention time with the design volume of the pond and the volumetric flowrate of the wastewater. However this does not take into consideration the non ideality of flow in the pond which has shortcircuiting and stagnant regions.

The non ideality of flow in the ponds can be characterised by determining the residence time distribution of the pond using tracers. Defining that Edt is the fraction of tracer in the exit stream that has a retention time between t and t+dt, then it follows that (9)

$$\int_0^\infty E\, dt = 1.0 \qquad (5)$$

and the mean retention time of the pond can be given as

retention time t $\times$ fraction of the effluent stream with a retention time between t and t+dt

$$=$$

fraction of effluent stream with retention time between t and t+dt

or

$$t = \frac{\int_0^\infty t\, E\, dt}{\int_0^\infty E\, dt} = \int_0^\infty t\, E\, dt \qquad (6)$$

The fraction of organic matter that is converted in the pond would depend on the time it spend in it. The summation of all elements of the effluent with the different retention time will give the overall conversion of the organic matter. Using the first order reaction for organic decomposition the resultant equation is

$$le = lo \int_0^\infty e^{-kt}\, E\, dt \qquad (7)$$

MATERIAL AND METHODS

The experiments were carried out at two ponds sites namely at the Wardieburn Army Camp and the residential area at Seri Serdang. The pond system at Wardieburn consists of two ponds in series and the latter consists of two identical systems in parallel each with two ponds in series (four ponds in total, considered as two pond systems namely SS1 and SS2). The total pond volume at Wardieburn is 16500 m3 and that at Seri Serdang is 12000 m3 (total for two ponds in series).

The sampling was carried out using the Manning S-4040 automatic sequential sampler. A 24 hr measurement were done by taking 2 hourly composite samples (sampling at every 15 minutes interval). The parameters analysed are the biochemical oxygen demand (BOD), chemical oxygen demand (COD), suspended solids (SS), Oil and Grease, alkalinity, Total Kjedahl Nitrogen, Temperature, pH, nitrate and ammoniacal nitrogen. All were analysed according to standard methods(11) except the last two parameters which were done using the Hash water quality kit. The dissolved oxygen (DO) was measured in-situ at depths of about 5 and 50 cm from the surface. The time of measurement correspond to the minimum (before 10:00 am) and maximum (between 2:00 and 4:00 pm) DO value expected for the day.

The flow measurements for the Seri Serdang ponds were done using Parshall flumes. This was carried out on six different days each for a period of 24 hr. Flow data for the Wardieburn pond were obtained from City Hall (data from 1970 to 1975 and extrapolated for latter years based on population served).

To characterise the pond at Seri Serdang, a joint study using radiotracer was carried out with the help of the Atomic Energy Unit (UTN). In this case a pulse input of radioactive tracer Tritium was added to the influent of the pond. The respond was determined by sampling at the outlets of the first and second ponds. The Tritium has a half-life of 12.4 years and therefore its disintegration can be ignored in calculating the residence time. Tritium is naturally available in the environment with a base value of approximately 200 cpm counts per min-20min).

RESULTS AND DISCUSSION

Mean Hydraulic Retention Time

The designed hydraulic retention time for the Seri Serdang pond systems SS1 and SS2 are 7.7 days each and that for Wardieburn is 9 days. The present retention time for the Wardieburn pond estimated from population projection is only 5.7 days. This is due to overloading and sludge accumulation in the first pond. The present population served is 12000 compared to the designed capacity of 8000 only. The amount of sludge accumulated at the first pond was measured at 3570 m3 after 15 years of operation.

The volumetric flowrate for each of the ponds systems at Seri Serdang were found to range from 1040 m3/day to 1310 m3/day with an average of 1220 m3/day. This corresponds to a mean hydraulic retention time of 9.6 days.

The retention time of the pond can also be calculated using the tracer studies. The respond obtained from the experiments are given in Figures 1 and 2. Using equation 6 the retention time for the first pond is calculated to be 3.3 days and 5.6 days for the two ponds in series. Compared to the value obtained using flow measurements, the actual retention time is lower. This is due to the sludge accumulation and the ineffectiveness of certain sections of the pond (dead zones and short-circuiting occurs).

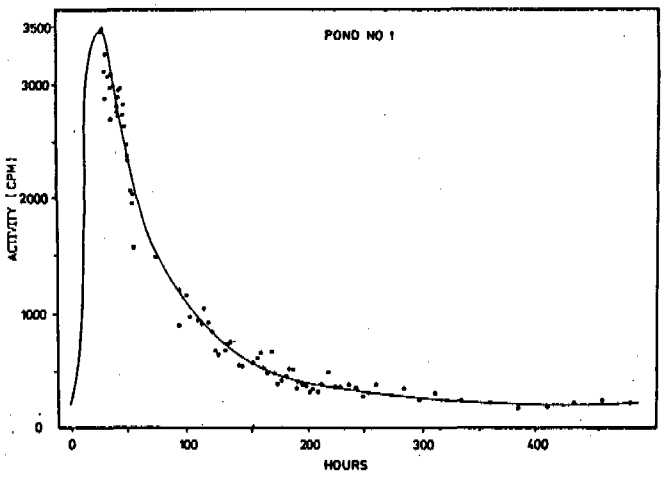

Figure 1. Response at the exit of first pond

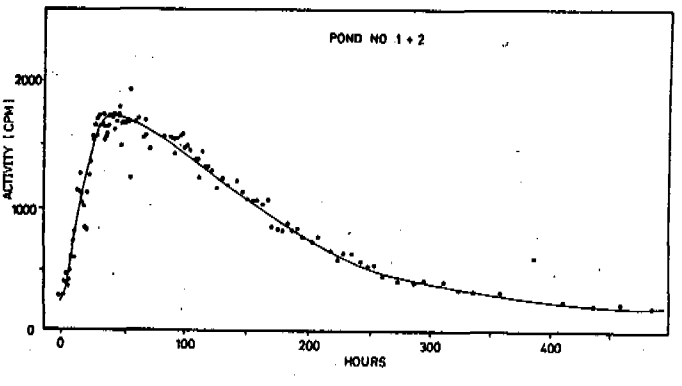

Figure 2. Response at the exit of two ponds in series

Effluent Quality

BOD The input BOD data for Seri Serdang ponds system I and II are given in Figure 3. The data is the average of 5 different sampling days and categorised into two-hourly intervals. The average influent BOD is 137 mg/l with a maximum of 188 mg/l and the average effluent BOD were 28 and 35 mg/l respectively. The removal efficiency in terms of quality is between 74 to 80%. As for the Wardieburn pond, the efficiency reduces from 80% BOD removal to 70% after 15 years of operations. However it has to be noted that the pond was oversized during the initial period and overloaded at present.

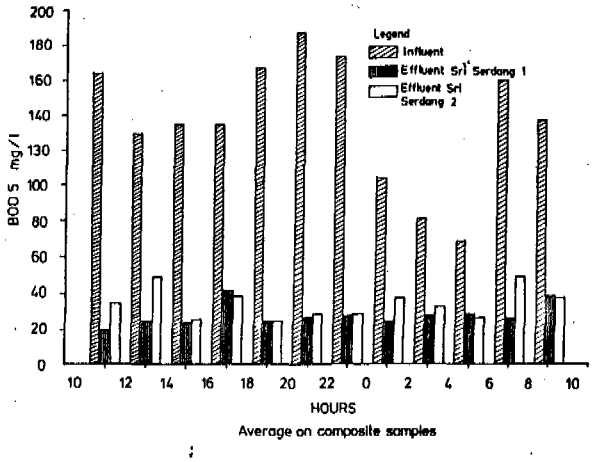

Figure 3. Daily average of 2 hourly composite samples (BOD)

The BOD removal is not totally due to bio-oxidation. Test on the influent water shows that the BOD reduces by as much as 30 to 70 % , with an average of 47% simply by letting the sample settled for 2 hours.

COD The COD data were also obtained from the same samples. The influent COD at the Seri Serdang pond ranges from 140 to 300 mg/l with an average of 210 mg/l (Table 1). The effluent COD averages at 114 and 120 mg/l for the parallel pond systems. The average influent and effluent COD for Wardieburn were 202 and 112 mg/l respectively(Table 1).

The reason for the high COD value can be due to limited oil and grease removal (Table 1) and the growth of algae. The latter was confirmed by filtering the effluent prior to COD analysis. The results on 13 samples showed the average ratio of filtered to unfiltered sample to be 0.6. Therefore the effluent after algae removal can be about 56 to 80 mg/l.

Suspended Solids The average influent and effluent suspended solids (SS) are given in Table 1. The effluent for the Seri Serdang pond 1 and 2 were 46 and 92 mg/l respectively. The inlet and outlet for Wardieburn pond were 141 and 68 mg/l respectively. Here again the high SS is mainly due to the presence of algae.

Table 1. Daily average of the inlet and outlet water quality (values given are means with standard deviations in parenthesis)

	Seri Serdang			Wardieburn	
	in	outl	out2	in	out
Temp. (C)	29(1)	30(1)	30(2)	29.5	33.6
pH	7.3(0.1)	7.4(0.1)	7.7(0.1)	7.0(0.1)	7.4(0.1)
Alkal.(mg/l CaCO3)	198(26)	162(5)	166(5)	-	114(5)
COD (mg/l)	210(53)	114(10)	120(19)	202(83)	112(18)
SS (mg/l)	199(126)	46(20)	92(45)	141(58)	68(15)
N-NTK (mg/l)	23(5)	22(1)	-	-	21(2)
N-NH4+ (mg/l)	0.9(0.2)	2.0(0.1)	2.1(0.1)	1.7(0.2)	2.0(0.1)
N-NO3- (mg/l)	1.6(0.2)	1.0(0.2)	0.6(0.2)	1.8(0.5)	0.9(0.2
O/Grease (mg/l)	154(64)	93(21)	-	-	-

pH, Alkalinity and Nitrogen Content The pH of the effluent of the pond are higher than the influent (Table 1). The increase in pH represents the uptake of carbon dioxide in the water by the process of photosynthesis. On the other hand the alkalinity of the wastewater decreases after treatment indicating the use of inorganic carbon by the algae is greater than the carbon dioxide input by bio-oxidation. Thus the photosynthetic activity of the pond is high and the biological process is low.

The degree of nitrification in the pond was low. Only the initial step of nitrification, the ammonification step occurs (Norg--->NH4+). The Total Kjeldahl Nitrogen of the wastewater remained constant.

Modelling

In modelling the oxidation pond two methods for calculating the rate constant were used. The first is by assuming the ponds as ideal flow reactors such as the plugflow and the completely mixed flow reactors. The second is by the use of tracers to determine the actual residence time distribution of various fraction of water flowing through the ponds.

The two flow models PF and CMF were chosen as they represent the simplest models and also gives the two extreme volume efficiencies that can be expected. Uhlmann (7) , Mara (2) and Thirumurthi (8) have suggested the used of CMF models as it represents better, the dead zones and the short circuiting that is expected and also tends to overdesign the pond size.

For CMF model the rate constant can be calculated from equation (4) given that m=2. In the case of PF model the rate constant can be calculated using equation (3). The results are summarised in the Table 2. The k value calculated for the Wardieburn pond is base on the 1985 data and taking into account of volume loss due to sludge accumulation.

Table 2 k values (day-1)

location		Pond 1+2	Pond 1
Wardieburn	PF	0.237	0.408
	CMF	0.345	0.675
Seri Serdang	PF	0.134	
	CMF	0.180	
	RTD	0.385	0.695
(2h settl)	RTD	0.210	0.325

The k value for the Seri Serdang ponds are also given in Table 2. These values were calculated based on the 24hr flow measurements. The k = 0.18 day-1 obtained for CMF was actually close to 0.17 day-1 value recommended by Marais (4). It is interesting to note that with the residence time distribution studies, the k value calculated by trial and error using equation (7) and Figures 1 and 2, is much higher. This is because the actual effective volume of the pond is reduced and there is settling particularly in the first pond. The effect of settling can be incorporated by using the BOD after 2 hr settling as the influent. In which case the k value of 0.21 day-1 that was obtained is more consistent.

The results from Table 2 also show that the k values calculated using CMF model approximates the RTD studies data better than the PF model. This shows that the CMF model is a better approximation to the actual situation. This is also evident from Figure 1 and 2 which resembles the shape expected from a single CMF and two CMF in series models respectively.

CONCLUSION

The effluent quality from oxidation ponds can comply with the requirements of Malaysian Effluent Discharge Standard B with the exception of COD and SS. This is mainly due to the presence of algae. The ponds studied regularly fail to meets the requirements of Standard A. The use of the CMF model to describe the ponds is a satisfactory assumption, in particular to the residence time distribution patterns obtained. A k value of 0.17-0.21 day-1 seems to be reasonable for the local condition. The former is appropriate to be used in conjunction with the CMF equations and the latter if more detail flow characteristics of the pond is known. The tracer study also shows that the pond design does not fully ultilise the total available volume of the pond and further work in this area should be done.

ACKNOWLEDGEMENT

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14th WEDC Conference

Water and urban services in Asia and the Pacific

Kuala Lumpur 1988

Municipal wastes disposal in groundwater

Nasiman Sapari

INTRODUCTION

Refuse decomposition in a landfill is influenced by many factors. The main controlling factors are moisture and temperature. Moisture content, in many cases, is considered to be the most important variable affecting the rate of refuse decomposition and leachate production (Ref.1). Previous reported works on landfill simulation studies or lysimeter studies were primarily based on moisture contents which were at field capacity or below (Ref.2). In practice, however, many refuse disposal sites are situated below groundwater level. The use of mining pools in and around Kuala Lumpur as disposal sites is an example of the case. Therefore it is necessary to examine the decomposition processes under saturated moisture conditions.

MATERIALS AND METHODS

A leachate lysimeter was constructed from a PVC column with dimensions 4 m in height and 20 cm in internal diameter.

The construction of the lysimeter from the bottom upwards may be summarized as follows:

Top 0.05 m top pebble layer
0.40 m covering sand
2.50 m solid waste layer
0.79 m underlying sand layer
Bottom 0.19 m supporting pebble layer

This lysimeter was equipped with temperature probes and leachate sampling devices at different heights of the lysimeter, and facilities for periodical measurement of pH, Eh, and gas production. One opening was provided at the bottom of the lysimter for the drainage and sampling of the leachate. At the top cover, two openings were made, one had a slightly lower projection tube for the input water, and the other for a gas outlet. Two water tanks, of 31 I capacity each, one at a level higher than the top of the lysimeter and the other at a lower level were used for feeding water into the lysimeter. Both tanks were connected to a pump, the lower tank was used for feeding the higher tank, and the higher tank was used for feeding the lysimeter.

Solid waste with a composition similar to the average composition of municipal waste was packed inside the lysimeter to a thickness of 2.5 m. The composition of the solid waste is shown in Table 1. A total of 43.775 kg solid waste was used for filling up the lysimeter with a packing density of 0.52 g/cm .

Table 1: Solid waste composition wet weight percentage. * (Ref.3)

Composition	In lysimeter	Range from 8* municipalities in Perth
Paper	24.0	21.6 - 34.5
Food waste	48.6	30.3 - 48.9
Garden waste	13.6	0.9 - 10.9
Metal	6.1	4.6 - 11.8
Wood	0.3	0.1 - 0.8
Rag	0.5	1.2 - 2.9
Others (glass,plastic and inert waste)	0.0	15.1 - 22.8

The solid waste was processed by cutting it into small pieces (average size between 1 and 2 cm) and mixing it thoroughly before packing.

Lysimeter Initiation

Water was introduced into the lysimeter gradually from the bottom part by using a plastic tubing connected to the higher tank through a control tap. A total of 49.9 I water was introduced into the lysimeter. The level of the water and the pressure inside the lysimeter was monitored by an open ended plastic tubing, connected to the lower part of the lysimeter, placed vertically at the side of the lysimeter to a level as high as the feed tank.

Monitoring And Analysis

The lysimeter was monitored over a period of two years. Gas production and temperature levels from four locations inside the lysimter were monitored. A gas meter was connected to the gas outlet tubing for the measurement of total gas production. The ratio between carbon dioxide and other gases

(predominantly methane) was determined by bubbling the gas sample to and fro, for the removal of carbon dioxide by KOH, to a constant volume.

leachate samples were collected from the bottom and middle taps of the lysimeter for quality analysis. The middle tap provided leachate samples from the middle of the refuse layer while the bottom tap provided leachate which had passed through the 1 m layer of sand. The parameters measured were pH, Eh, BOD, COD, ortho-P and ammonia.

A total of 7.8 l water samples were collected from the bottom drainage over the first year. During the second year, a total of another 7.1 l of samples were collected. The total water withdrawned from the lysimeter over the two year period was equivalent to 1.1 pore volume of the bottom pebble and sand column. Thus a slow rate of leachate introduction into the sand column was maintained in order to promote establishment of methane fermentation processes.

After six months, a steady methane content of approximately 55% (with variation around 3%) was achieved. Further determinations of the methane content indicated a gradual increase from 55% to about 65% after one year (Figure 1). The Eh level of the leachate dropped very rapidly to below - 250 mV (Figure 2). This Eh level was found to be consistently low throughout the study period. The pH of the leachate sample from the middle of the lysimeter was always low with an average of 5.3. However very slow release of leachate from the bottom tap was found to increase the pH from levels of around 5.5 to above 7 after six months operation (Figure 2).

The leachate from the middle of the refuse layer contained vey high levels of ammonia and COD. With minimal water circulation the levels remained very high even after 22 months operation (Table 2).

Table 2: The characteristics of leachate from the middle of the refuse layer.

Parameter	Concentration (mg/l)
COD	36,100
BOD	22,500
Ammonia-N	1,700
Ortho-P	12
pH	5.3

Leachate Stabilization in the Underlying Sand Layer

Introduction of the high strength leachate

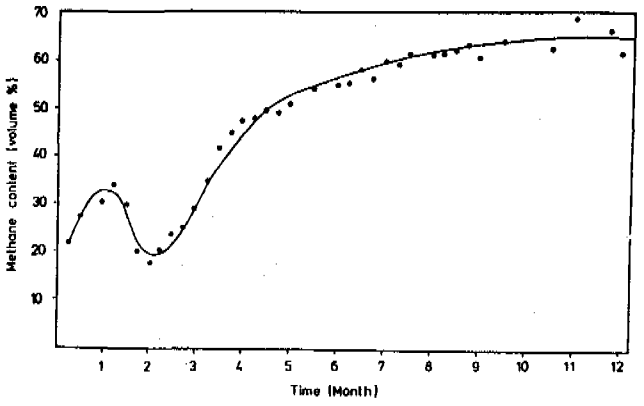

Figure 1 Methane content of the lysimeter gas.

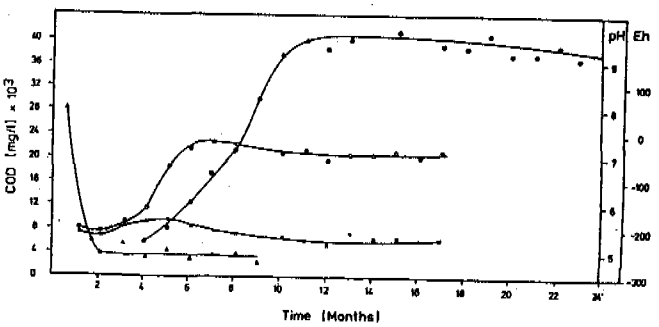

Figure 2 Characteristics of leachate from the lysimeter. (●), COD; (○), pH of samples from the bottom drainage; (×), pH of samples from the middle solid waste layer and (▲), Eh.

might result in a lowering of the pH of the sand layer hence inhibiting the methane fermentation process. This situation was taken into consideration and controlled by regulating the leachate movement so as to allow dilution of the organic load through diffusion.

The quality of the leachate collected from the bottom drainage indicated that the bottom sand layer had acclimatized to the conditions necessary for the methane fermentation process (Ref.4). The stability of this condition was tested by introducing one test load of COD.

After the test load and a rest period of about 8 weeks, a continuous loading experiment was carried out. leachate generated by the solid waste layer was introduced into the underlying layer by weekly drainng 1.5 l of leachate from the bottom drainage. At this draining rate it was calculated that the leachate would have an average detention time of 9 weeks and an infiltration rate of 1.6 cm/day. This calculation was based on the total pore volume of the sand and the supporting pebble layers divided by the volume of the leachate collected weekly. Obviously gas was developing inside the sand layer and the effective pore volume had become smaller; therefore the actual detention time could be shorter than the calculated value.

The continuous loading experiment lasted for about 3 months. During the period, samples of leachate from the bottom drainage, the base of the solid waste layer and the middle of the solid waste layer were collected every week. The samples were analysed for pH, COD and BOD. Nutrient levels namely Ortho-P and Ammonia-N were also determined. Redox conditions (EH) were also detrmined during the collection of samples.

The volume of the leachate samples collected every week from the bottom drainage, the base of the solid waste layer and the middle of the solid waste layers were measured separately. The sum of the volume collected was recorded. Replacement water of similar volume was then introduced into the lysimeter through the top water inlet.

A total of 18.7 l of leachate was collected from the bottom drainage over the period of the continuous loading experiment. The total amount of leachate collected was equivalent to about 1.4 pore volumes of the underlying sand and pebbles layers.

RESULTS AND DISCUSSIONS

pH and Eh

Results of pH measurements of the leachate from the bottom and the middle of the solid waste layer indicated that the pH from both sources remained approximately constant throughout the extire experiment. The pH of the leachate samples from the bottom drainage was always higher than 7 with an average of about 7.3 while the pH of the leachate samples from the middle of the solid waste layer was always low at around 5.3.

Introduction of replacement water through the top of the lysimeter apparently did not affect the pH conditions inside the solid waste layer. At the existing pH conditions, methane fermentation was not likely to take place inside the solid waste layer. The most favourable condition for the methane fermentation to take place was at the base of the solid waste layer or in the underlying sand and pebble layers where the pH was around 7.

Redox conditions inside the lysimeter (Eh) showed a reducing trend as the leachate moved from the top to bottom. The Eh conditions in the middle and the bottom of the lysimeter were - 100 mV and - 265 mV respectively. Only three Eh measurements could be taken from the base of the solid waste layer. These measurements had an average value of - 208 mV. Further measurements were not possible because this part of the lysimeter was occupied by gas.

Reduction of Organic Materials

Results of the COD analyses are presented in Figure 3. Prolonged rest periods of several months resulted in production of excessive concentrations of organic acids. This non-methenogenic anaerobic process was likely to be the dominant process that took place inside the middle of the solid waste layer. levels of COD higher than 53,000 mg/l in the leachate samples collected from this part of the lysimeter suggests that this is the case. At this level of COD and low pH, methane fermentation is not likely to take place.

Mobilization of this concentrated leachate through the underlying sand and pebble layers by controlled flow was found to have reduced the COD to an average level of about 2,000 mg/l (Figure 3). The COD of the leachate samples from the bottom drainage remained at about this level throughout the entire experiment.

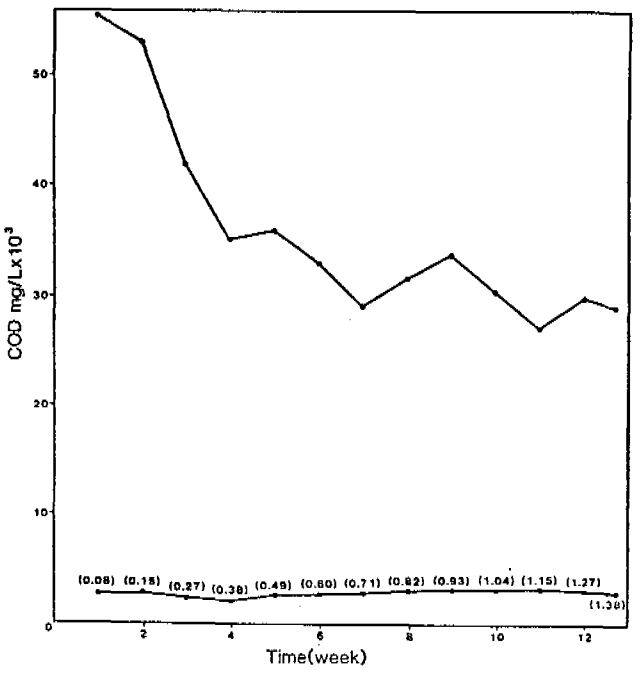

Figure 3: COD levels in leachate samples from the lysimeter collected from the middle of the solid waste layer (●) and the bottom drainage (■) during the continuous loading experiment; (x.yz) = pore volume drained.

COD removal was calculated from COD values of the leachate inside the solid waste layer as the influent and the leachate from the bottom drainage as the effluent. The removal was found to be between 92.2 and 96.2 percent.

The COD levels in the leachate from the solid waste layer decreased gradually from 55,500 mg/l to 30,000 mg/l as the leaching continued. The average COD level in the influent leachate was 33,800 mg/l. At the draining rate of 1.5 l/week, the organic loading into the underlying sand layer was found to be 50.7 g/week.

Results of the BOD analyses for leachate samples collected towards the end of the continuous loading experiment indicated that the average BOD in the effluent was 290 mg/I. The same analyses for the leachate collected from the middle solid waste layer provided an average value of about 20,000 mg/I. From these figures, it was found that a removal efficiency of 98.5 percent was achieved.

CONCLUSION

High strength leachate generated by a young landfill (<5 years) can be stabilized by controlled infiltration through the underlying sand layer under saturated conditions. Simulated conditions in a laboratory leachate lysimeter indicated that COD levels as high as 55,000 mg/I can be removed in the 1 m sand layer at the bottom of the lysimeter.

Removals of COD and BOD of greater than 92 percent and 98 percent respectively were achieved after 9 weeks detention with a leachate mobilization rate through the sand layer of 11 cm/week.

At this infiltration rate and with influent COD concentration of between 30,000 and 55,000 mg/I (based on the concentration in the middle of the solid waste layer), the organic loading rate to the underlying 1 m sand and pebble layers was equivalent to 476 g COD/m pore volume/day.

Rapid breakdown of organic materials by anaerobic fermentaiton resulted in a high rate of gas production (Ref.5). An average gas production 77 ml/day/kg wet weight of solid waste was achieved during the continous loading experiment. Under saturated conditions, rapid methane fermentation could take place inside the underlying sand layer or at the base of the solid waste layer but it unlikely to occur inside the middle of the solid waste layer. This was because of the low pH (around 5) inside the solid waste layer associated with the very high COD.

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Water and urban services in Asia and the Pacific

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Domestic wastewater and excreta treatment

Mohamad Pauzi Zakaria

and Md Fiah bin Md Jamin

1.0 INTRODUCTION

Kajang is a small town located about 25 kilometers south of Kuala Lumpur. Due to it's strategic location, the Kajang township has grown tremendously in the last ten years. Presently, it is the main trading, administrative, housing plus scores of other activities in Ulu Langat District. Figures 1 and 2 show the study area and the sampling locations respectively.

1.1 MATERIAL AND METHODS

The study was divided into four parts. The first part involves surveying the study area to identify the types of sewage treatment and domestic wastewater disposal systems for residential and business premises. The second part of the study was the analysis of water samples taken from the six sampling stations. The next part of the study was the water quality analysis of the effluent taken from three selected sewage treatment systems i.e an Imhoff tank, an oxidation pond and a septic tank. The Imhoff tank is located at Kampung Sri Jambu and it has been operating for six years. It serves a total of 26 houses. The oxidation pond selected for the study was located at Taman Kajang Baru and Sungai Jelok and it serves 523 houses. The effluent from the septic tanks was taken at Taman Mahkota from each individual houses.

The last part of the study was the analysis of domestic wastewater. The water samples were taken at the effluent pipe of Kajang Police Station Flats.

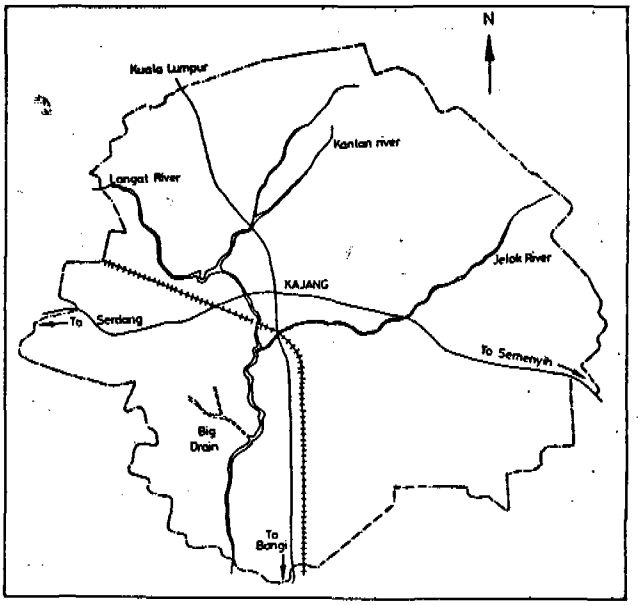

Figure 1 The area of study (Kajang Town)

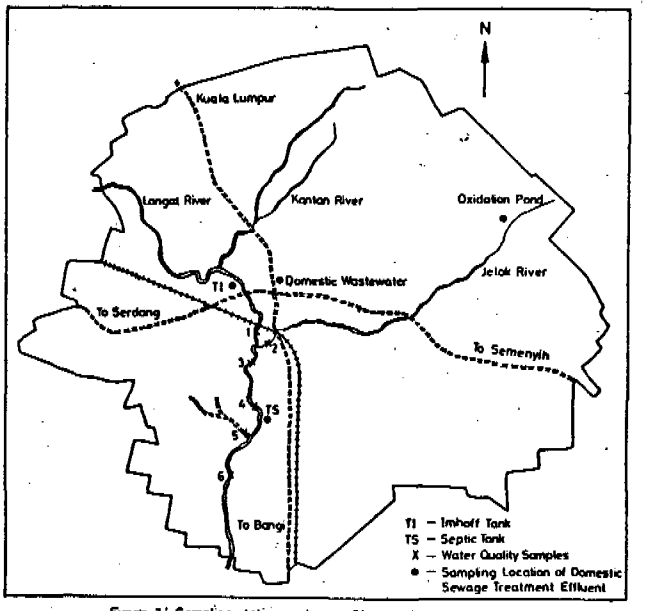

Figure 2 : Sampling station on Langat River and wastewater effluent.

1.2 Water quality parameters

The parameters measured in the study are included temperature, pH, dissolved oxygen, conductivity, alkalinity, turbidity, 5-day B.O.D, total coliform, total nitrogen, C.O.D, suspended and dissolved solids. The parameters such as pH, temperature, dissolved oxygen and conductivity were measured in situ and whenever possible were verified in the laboratory. The other water quality parameters like suspended solids, total solids, biochemichal oxygen demand, chemical oxygen demand, alkalinity, turbidity, total nitrogen and total coliform were analysed in the laboratory. All analytical methods were based on Standard Methods (APHA, 1985).

2.0 RESULTS AND DISCUSSION

2.1 Sewage treatment systems

There are four types of treatment systems available. They are the septic tanks, Imhoff tanks, oxidation ponds and bucket laterines (night soil are later

treated by the Majlis Daerah Hulu Langat). However, a significant number of houses did not have any waste treatment system; raw sewage is released directly into the Langat River. Table 1 shows the number of houses with different treatment systems while Table 2 shows the water quality data for the whole study.

2.2 Sungai Langat water quality

On the average, the dissolved oxygen concentration was within the expected values except for sampling station number 5 which has dissolved oxygen levels of 3.4 mg/l i.e relatively low when compared with other stations. This low dissolved oxygen content might be due to the high organic load recieved from the huge moonsoon drain which is located upstream. This is more evident when we examined the BOD5 value of 22.1 mg/l, which is about 100 percent more than that of other stations.

The COD levels for all stations is within the range of 27.8 mg/l to 68.6 mg/l. However, station number 5 again showed the highest concentration. For dissolved and suspended solids all stations showed a high range of 42.8 mg/l to 152.4 mg/l for suspended solids and 86.0 to 226.8 mg/l for dissolved solids. As for organic nitrogen, station 5 showed the highest level with 13.0 mg/l. Station 5 recieve discharges from the monsoon drains which contain domestic wastewater and solid wastes. This tend to increase organic nitrogen concentration in the water (Witt et. al, 1974).

Other parameters worth mentioning here is total coliform where all stations showed high total counts. This indicates that the Sungai Langat is contaminated with fecal metaerial. At this juncture it is very important to know the sources of contamination, whether it is due to the inefficiency of the treatment systems or due to the disposal of untreated sewage into the river or both.

Let us now look at the effluent quality from various sewage treatment systems sampled (Table 3). From Table 3, shows that the oxidation pond has the highest dissloved oxygen value of 2.9 mg/l. Septic tank has the highest BOD5 value of 81.6 mg/l while that of oxidation pond has the lowest value of 31.5 mg/l.

The effluent from the septic tank has the highest dissolved solid concentrations while the lowest value is the effluent from the oxidation pond. As for turbidity, again the septic tank shows the highest value.

For the conductivity levels, the effluent from the oxidation pond has the highest value of 328 umho/cm while that of Imhoff tank show the lowest value 196 umho/cm.

Table 1 Number of Houses with Different Treatment Systems

Treatment Systems	Number of Areas	Number of Houses	% Total
1. Septic tanks	28	4162	75
2. Imhoff tanks	5	611	11
3. Oxidation ponds	1	523	9
4. Night soil	1	30	1
5. Pit laterine	-	220	4

Table 2 Water Quality at Different Sampling Stations

	Stations					
Parameters	1	2	3	4	5	6
D.O (mg/l)	7.5	6.6	7.5	8.6	3.4	7.1
BOD5 (mg/l)	7.2	9.6	7.8	6.7	22.1	10.2
COD (mg/l)	27.8	34.6	28.6	30.8	68.6	36.8
S.S (mg/l)	141.0	112.0	138.0	152.4	42.8	134.2
D.S (mg/l)	104.4	86.0	91.2	84.4	226.8	90.2
Turbidity (FTU)	67.8	63.2	63.0	63.4	39.0	60.0
Conductivity (umho/cm)	39.2	45.2	39.4	38.6	83.2	54.4
pH	6.7	6.8	6.7	6.7	6.6	6.8
Temperature (C)	26.6	26.6	26.6	26.6	25.8	26.6
Alkalinity (mg/l as CaCO3)	5.5	10.7	5.0	4.3	4.9	6.1
Total Nitrogen (mg/l)	8.2	3.8	8.9	5.6	13.0	5.1
Total Coliform (X 1000/100 ml)	1.1	1.5	1.3	1.0	1.5	1.1

D.O = Dissolved Oxygen
BOD5 = Biochemical Oxygen Demand (5 days)
COD = Chemical oxygen demand
S.S = Suspended solids
D.S = Dissolved solids

3.0 CONCLUSION

This study has shown that the effluent from wastewater treatment systems and domestic wastewater has increased the value of certain parameters in the Sungai

Table 3 Effluent Quality for Various Treatment Systems

	Treatment Systems			
	A	B	C	D
Parameters				
Dissolved Oxygen (mg/l)	0.7	2.9	1.6	0.7
BOD5 (mg/l)	80.0	31.5	35.2	81.6
COD (mg/l)	257.6	95.4	115.4	254.8
Suspended Solids (mg/l)	688.2	85.0	103.0	671.4
Dissolved Solids (mg/l)	312.8	117.4	248.4	363.0
Turbidity (FTU)	47.2	16.4	14.0	47.6
Conductivity (umho/cm)	196.0	328.0	296.0	206.0
pH	6.7	6.7	7.1	6.7
Temperature (C)	26.4	25.9	26.0	26.8
Total Coliforms (X 100 000/100 ml)	9.2	5.0	5.7	10.3

A = Imhoff Tank
B = Oxidation Pond
C = Domestic Wastewater
D = Septic Tank

Langat. Wastewater disposal into Sungai Langat had reduced the dissolved oxygen concentrations and conversely had increased the BOD. Pyrde (1974) had also shown similar pattern in his study. Depletion of dissolved oxygen levels may result in fish kills and other undesirable effects to Sungai Langat.

This study has also shown that a sizeable number of Kajang population used septic tanks for wastewater treatment. With proper maintenance, this type of treatment is quite good. Qualitative analysis of the effluents from the various treatment systems, showed the effluent from the oxidation ponds has the best quality having values of BOD, COD, suspended solids, dissolved solids and total coliforms of 31.5 mg/l, 95.4 mg/l, 85 mg/l, 117.4 mg/l and 50,300 counts/100 ml respectively.

It is therefore recommended that Kajang township should upgrade their wastewater treatment facilities in order to reduce the organic loads from the wastewater to the Sungai Langat. It is also recommended that oxidation ponds be selected as a suitable the treatment systems since it has been shown to have the best effluent quality.

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SESSION II
WASTEWATER TREATMENT

Chairman: Associate Professor Dr Fauzi bin Abdul Samad
Deputy Dean, Research & Consultancy Unit
Universiti Teknologi Malaysia

PAPERS PRESENTED

NIK FUAAD NIK ABLLAH
Package treatment plant utilizing RBC

Dr R AHMAD, R ABDUL AZIZ and A HUSSEIN
Palm oil mill effluent treatment

Dr A SUKI, H JENNY and MD RASHID
Efficiency of oxidation ponds

NASIMAN SAPARI
Municipal wastes disposal in ground water

MOHD PAUZI ZAKARIA and MD FIAH BIN MD JAMIN
Domestic wastewater and excreta treatment

DISCUSSION

NIK FUAAD NIK ABLLAH

1. Professor BLAKEBROUGH commented that RBCs were not an attractive visual feature of householders' compounds compared with underground septic tanks. He asked if they would give rise to odour problems.

2. Mr NIK FUAAD explained that RBCs could also be situated underground. Reinforcement needed to be provided in peripheral walls. If properly maintained, RBCs produced less smell than oxidation ponds, percolating filters and septic tanks.

3. Mr KOLSKY asked if there was any information on treatment efficiency in terms of pathogen or bacterial removal. He suggested that the first responsibility of public health engineers, in considering treatment efficiency, must be in terms of pathogen removal and not the removal of COD or ammonia. In public health terms it is not clear that RBC systems are an improvement on bucket systems as pathogens may not be removed before their dispersion into the environment. Pit privies may be preferable in at least isolating the waste. He asked how it was intended to dispose of the effluent.

4. Mr NIK FUAAD replied that they had not investigated the bacterial removal efficiency but said that did not mean this system did not have the ability to remove bacteria. Organic matter was just as important since it could cause water pollution and could cause the rivers to die.

5. Mr KOO HOCK SONG commented that Majlis Perbandaran Pulau Pinang had approved the installation of an RBC package treatment plant at Wayton Development, Paya Temboing. It was in operation and the effluent quality was good but this may be because it had not been loaded to its design capacity. Sludge would be removed by the Council on request until the plant was handed over to the Council for maintenance. However, Mr Koo considered that the RBC was not suitable for small developments.

6. Mr NIK FUAAD said the RBC had been proven to be an efficient treatment system for large or small housing schemes but was probably not economical for less that 100 units due to its high capital and running costs. He explained that their efforts had been to produce a compact on-site treatment plant. The RBC had many advantages although it was expensive to operate.

7. Mr RICHARDSON asked if there was any information on capital and operating costs of RBCs in Malaysia.

8. Mr NIK FUAAD replied that the one that had been assembled had cost about M$4000. If they were mass produced the capital cost should be about M$2000. The operating cost would be approximately M$3.00 per month for electricity for the motor only.

9. Mr RICHARDSON also wished to know if there was any practical experience of their application in Malaysia, excluding research.

10. Mr NIK FUAAD stated that there were several used for small housing schemes. In Penang State there were three in operation.

Dr R AHMAD

1. Mr PIGGOT presumed that, as the peat used in the process was readily available cheap material, regeneration may not be cost effective or necessary. He wished to know what consideration was being given to the disposal of colour and metal contaminated spent peat.

2. Dr AHMAD explained that the peat could be regenerated by an acid treatment process. In the case of metal contaminated spent peat, the regeneration process was relatively cheaper than producing freshly prepared modified peat. Colour contaminated spent peat could also be reactivated but that was less viable.

Dr A SUKI

1. Mr HUTTON noted that in Table 1 the first tritium count was measured after 40 hours and asked if this was the first sample. He asked if Dr SUKI had considered the work of Mr J P Arthur published by the World Bank. (ARTHUR J P. Notes on the design and operation of WSP in warm climates of developing countries, UD Technical Paper No 6, World Bank Publication 1983). He said that tritium is a useful tracer for tank hydraulics and suggested it could be used for future modifications made to tank design.

2. Dr SUKI said the first point/sample count was after 24 hours. He had not considered the work of J P Arthur but would make a note of it. He said he intended to carry out tracer studies with tritium for further studies on tank design modifications.

3. Dr KAWAMURA asked for some information about the effluent standards of some typical parameters, for example, from wastewater plants of industrial and residential areas.

4. Dr SUKI explained that there were three effluent discharge regulations in Malaysia. One was specifically for the rubber industry, another was for the palm oil industry and the third was for other industries, including the discharge from sewage treatment works. For the sewage effluent there were two standards A and B. The former was for rivers used as drinking water sources and the latter for rivers not used for drinking water sources downstream. The BOD levels for standards A and B were 25 and 50 mg/l respectively and the COD levels 50 and 100 mg/l respectively. The level for SS was similar to that of COD.

5. Mr TANG commented that in the paper it was mentioned that the ponds studied regularly failed to meet the standard A requirement. What would the author anticipate if the retention time was, say, doubly increased, ie from 9 days to 18 days for Wardieburn STP.

6. Dr SUKI replied that increasing the retention time may not be a good way to meet the standard. The difficult standard to meet was the COD and SS values and this would not necessarily improve with long retention time as the problem was mainly due to algae growth. The BOD removal could be improved with retention time. This was best carried out by improving the hydraulics and reducing short circuiting. There was no point in increasing the pond size if there was serious short circuiting. In this case the actual mean residence time could still be quite short.

7. Mr TSEN wished to know how to design an oxidation pond to comply with the Malaysian Effluent Discharge Standard A under Malaysian conditions.

8. Dr SUKI explained that with a better pond design in terms of flow it was possible to remove/reduce BOD to the standard A requirement. However, it was difficult to remove/reduce COD and SS because with the present process algae was not removed. A process to do this was still being studied.

MOHD PAUZI ZAKARIA

1. Dr COTTON wished to know if the septic tank effluent discharged into the river, or into soakaways. He commented that oxidation ponds would only be the optimum solution if septic tank effluent went to the river. In addition, oxidation ponds required a local sewerage network which had be incorporated into the cost benefit analysis.

2. Mr MOHD said that the septic tank effluent was discharged into the river. He agreed with Dr COTTON's other comments.

3. Mr KOLSKY asked if there was any reason why total coliforms were used as a measure in preference to fecal coliforms.

4. Mr MOHD said there was no reason for this.

5. Mr KOLSKY queried how one could conclude that oxidation ponds were effective treatment in comparison with other systems of treatment, without knowing the influent concentrations.

6. Mr MOHD said that he was only looking at the effluent quality and not the efficiency of the treatment systems.

7. Mr PIGGOT commented to all the authors in this session that the general practice in Asia was to connect septic tanks directly to monsoon drains/watercourses. This practice was strongly discouraged by WHO etc. He also said that proliferation of single household treatment plants (RBC, small dissolved air extended aeration plants etc) could be a major operations and maintenance problem for the future.

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Water and urban services in Asia and the Pacific

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Establishing environmental monitoring in Sri Lanka

L G Hutton

Environmental Monitoring in Sri Lanka

There were 13 organisations in Sri Lanka in 1987 registered by the Central Environmental Authority (CEA) to carry out tests on water, soil, air and noise for environmental purposes. All of these laboratories have some facilities for testing water, five can test soils and only two can measure air and noise pollution. The organisations are listed in Table 1 (CEA), 1987).

Standards for various types of environmentally sensitive parameters discharged are prepared by interagency drafting committees, with representatives from organisations whose interests are involved, are published by the Sri Lanka Standards Institution. Other national and international standards for discharges are often used when drafting local limits. The standard methods of analysis for these parameters are also defined by the Sri Lanka Standards Institution. All these standards are subject to review as new problems and developments arise.

Some interlaboratory comparisons were carried out by CEA and the Centre for Analytical Research and Development, Dept. of Chemistry Colombo on 11 laboratories using chloride, sulphate, calcium, magnesium, sodium, zinc and copper on a synthetic potable water. The exercise proved very informative and has tightened up procedures in the participating laboratories. It is hoped to carry out some further comparisons in future (Gunawardhana, 1986).

It is interesting to note that despite the promising potential for environmental monitoring there is currently:

1) No surveillance organisation for regular checking of drinking water quality.

2) Few reports submitted to the Global Environmental Monitoring System, especially in relation to water quality.

The reasons for this state of affairs are several and probably synergistic:

1) Lack of awareness by the public on environmental and public health matters.

2) Lack of funds for purchase and maintenance of supply of chemicals and simple and complicated laboratory equipment.

3) High rate of staff turnover at professional and technical levels.

4) Pressure on provision of quantity of water rather than maintenance of quality of supply and distribution networks.

5) Concentration of industrial development in Colombo and its surrounding districts.

National Building Research Organisation (NBRO) and its Environmental Division

The National Building Research Organisation had its origins from the Building Research Institute and was founded at its present site in March 1984. Its work is directed towards the research and development needs of the total shelter sector. Its activities focus on five broad areas:

Geotechnical Engineering,
Building Material and Construction Techniques.
Human Settlements Development.
Environmental Management.
Structural Engineering and Project Management.

The Environmental Division was established in January 1986 with a view to provide research and technical assistance to the Urban Development Authority (UDA) to combat urban environmental pollution. The aims and objections of the Urban Development Authority are very briefly described in Appendix 1.

Development activities stress the environment, causing pollution in urban areas. Urban Development does not merely imply building construction. It includes all activities that are accomplished to improve urban areas such as promoting commercial development housing, providing

infrastructure, services and amenities such as public parks as well as industrialization. So in some cases while the standard of living may improve, the urban environmental quality may deteriorate both during construction and afterwards with increased activity.

Laboratory Facilities and its Establishment

Although there have been cases of gross pollution in urban areas in Sri Lanka, it has been difficult to quantify such incidents. A modern environmental laboratory with the capacity to monitor water, air and noise pollution is being equipped with UNDP-UNCHS funding.

The author visited Sri Lanka as UNCHS Environmental Consultant to NBRO for 6 weeks ending December 1986 primarily to review the equipment needs of the environmental laboratory and to finalise the list of equipment for procurement including detailed specifications and cost estimates.

In December 1987 the author returned for 3 months to install, commission and calibrate the equipment which was arriving at NBRO. The author will give a status report at the conference.

The equipment procurement has been split into two stages and the major components for phase 1 and phase 2 (draft) are listed in Table 2.

The training of staff in environmental analysis techniques and sampling will be illustrated by slides as well as some of Sri Lanka's environmental problems which are being researched.

Disclaimer

The views expressed are those of the author and do no necessarily those of the UNDP, UNCHS, NBRO or Sri Lanka Government.

Acknowledgements

The author wishes to thank UNCHS and UNDP for funding the project and to the staff of NBRO especially those in the Environmental Division for all their help and assistance.

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Appendix 1

AIMS AND OBJECTIVES OF THE URBAN DEVELOPMENT AUTHORITY

The Urban Development Authority since its inception in October, 1978 has declared 79 Urban Local Authorities under the U.D.A. Act No 41 of 1978.

The Aims and Objectives of the U.D.A. regarding the above are the following

a) To carry out integrated planning and physical development.
b) To implement programmes in order to provide services in such areas that are consistent with integrated planning.
c) To undertake and execute development projects.
d) To formulate capital improvement programmes for the declared areas.
e) To formulate and implement an urban land use policy for the whole of Sri Lanka.
f) To develop environmental standards and prepare schemes for environmental improvement.
g) To carry out building, engineering and other operations and connected infrastructure development of such areas.

In order to implement the above programme the Urban Development Authority is empowered to

a) Enter into any contract with any person on organisation for the execution of development projects and schemes approved by the Government.
b) To acquire and hold any movable or immovable property acquired or held by it.

Table 1

List of laboratories registered in 1987 by the Central Environmental Authority to carry out environmental monitoring (CEA,1987).

Institution Name	Parameters for which facilities are available			
	Water	Soil	Air	Noise
1. Ceylon Institute Scientific and Industrial Research (CISIR)	x		x	x
2. Colombo Municipal Council Microbiology lab	x			
3. Division of Occupational Hygiene	x		x	x
4. Geological Survey Dept.	x	x		
5. Government Analyst's Dept.	x			
6. Land Use Division, Irrigation Dept.	x	x		
7. National Water Supply and Drainage Board	x			
8. Sri Lanka Standards Institution	x			
9. University of Colombo, CARD	x			
10. University of Kelaniya, Botany.	x	x		
11. University of Kelaniya, Chemistry.	x	x		
12. University of Peradeniya Zoology.	x	x		
13. Water Resources Board.	x			

Table 2

Equipment for Environmental Laboratory, NBRO Sri Lanka

Phase 1	Phase 2
Analytical Balance	Air Meter
Autoclave	Autoclave
Centrifuge, hand	Balance, electronic
C.O.D Apparatus	Barometer
Comparator and discs	Bath, water for bacteriology
Conductivity Meter	Centrifuge
Deioniser	Colony counter
Distillation Unit	Conductivity/Temperature water meter
Dust sampler, Hi-volume	Dissolved oxygen meter
Earth Leakage Residual Current Device	Distilled water apparatus & reservoir
Flame photometer	Hotplate
Fume cupboard	Incubator
Furnace, Muffle	Kjeldahl apparatus *titrator
Gas meter, pumps and bubblers	Potable pH/specific ion meter
Hot plate	Potable ambient air monitor
Incubators	Recorder, chart
Multimeter	Sound level meter
Oven, Hot air	Turbidity meter
pH/specific ion meter	Portable laboratory for water and wastewater
Refrigerator	
Spectro-photometer and cells	
Stirrers	
Sound level meter	
Toolkit	
Vacuum pump	
Water bath	
Water sampler	
General laboratory equipment	
Glass ware and plastic ware	
Chemicals	

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Information consolidation of pollution problems

Dr Suporn Koottatep and Dr Kiyoshi Kawamura

INTRODUCTION

1. The problems and phenomena occurring in the environment, such as air and water pollution, are composed of and related to various factors and aspects; for example technology development, public education, regulations, economics and finances. And relationships among factors and aspects of the problems can not be understood, in general, by the 1:1 relationship which is the most important and basic concept of natural sciences and engineering. However, it is necessary, for under standing problems well, to unveil the unseen relationship among the various factors and aspects relevent to the subjects and to simulate a clear and actual image.

THE K-J METHOD

2. The K-J method seems to be suitable for performing the above mentioned difficulties successfully. This method is for information synthesis and decision-making through several steps of grouping and relation-making of many individual data and/or observations. The method was invented by Dr.Jiro Kawakita, a renowned Japanese anthropologist, and conveniently named after his initials. The method was developed about 30 years ago in the process of attempting to synthesize data and informations gathered through anthropological field studies in Nepal. It has later received wide acceptance among planners, engineers and adimistrators in Japan

Basics steps of the K-J Method

3. The K-J method consists of four basic steps, which were card makings, grouping of cards, preparation of display digaram and explanation of display diagram (story making). The following outlines of these steps are summarized through the book entitle "Hassoho (in Japanese)" or a method for creative thinking written by Dr.Jiro Kawakita.

4. Card making is to gather all facts, ideas and useful pieces of information which are relevant to the problem statement or theme through brain-storming. A label maker will be selected and will construct keywords or very short sentences by extracting from the facts, opinions and ideas which reflects the intention of the contributing members through free discussion. In this step, any opinions and ideas should be accepted.

5. Grouping of cards will be performed as the second step. Cards will be then primarily grouped according to theirs concept. New descriptors will be written to represent each groups of cards. The secondary and tertiary grouping will be then performed and new higher level descriptor cards will also be obtained. Sometimes there will be cards which do not seem to belong to any other cards. Such cards are called "lone wolves". However, it may later play an important role in producing new ideas and then will be grouped at higher steps of grouping.

6. Preparation of display diagram will be later performed to draw diagram and display the relational structure of groups of cards. The first step was to place the descriptor cards of the highest order grouping on a paper according to theirs configuration. The next step should be proceeded by first identifying the relationships among descriptions of the highest order grouping and then consequently with lower order. The process repeats itself until the relationships among the individual cards are identified within the primary grouping of cards. The recommended symbols for use in drawing diagram is shown in Figure 1.

7. Explanation of display diagram will be the last step. The story will be then created to explain about the problems. Figure 2. shows the flow chart of grouping process and identifying process of relational structure.

APPLICATION FOR WATER POLLUTION PROBLEMS IN CHIANGMAI

8. Chiangmai have many problems on surface and groundwaters quality. The main cause can be recognised as the lack of proper system, in both technology and sociology, for wastewater treatment and disposal. However, if the cause-effect relationships in these problems are verified and explained, step by step, by applying the 1:1 relationships already known by experiments, the appropriate counter measures to the water pollution problems are still difficult to

———	Related with
———→	Derived from, causal relation, and the details from the whole
←——→	Mutually caused
>—<	Mutually opposed or contradictory
═══	Same
═/═	Not same
.˙.	Therefore
˙.˙	Because
e.g.	For example

Fig. 1 Recommended Symbols for Use in Drawing a Diagram

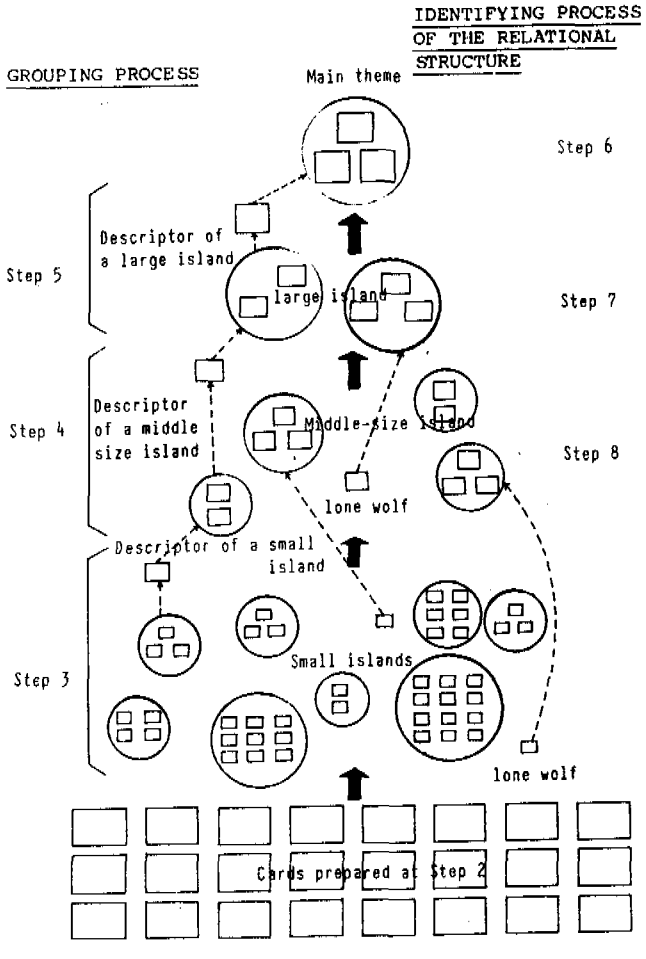

Fig. 2 Flow Chart of Grouping Process and Identifying Process of the Relational Structure

be found and shown in visual fashion. It is therefore necessary to apply the K-J method to consolidate the informations in Chiangmai area.

9. The K-J method was applied by initiating a brain storming discussion among the selected participants from different organizations involved in water pollution problems in Chiangmai area. Thirteen participants from municipality office, provincial public health office, Northern Industrial Promotion Centre, Social Research Insititute, Governor's office and department of environmental engineering Chiangmai university were involved in the discussion. After two and a half hours of discussion, 107 keywords and sentences were obtained.

10. The keywords and sentences were then grouped according to the procedures stated above. The result obtained from first step grouping was that 97 cards were classified by 23 new descriptors with 10 lone wolves. New descriptors were written on blue cards. Second grouping were then performed. Seven newly produced descriptors were prepared from eighteen descriptors and seven original cards and were written in pink cards. Five descriptors produced in the first grouping and three original cards were left as lone wolves.

11. Fifteen cards with seven descriptors produced during the second grouping and eight descriptors and original keywords left at the last step to grouping were then arranged on the table to display a rational and proper relational structure. The diagram was then produced from large group to smaller group.

RESULTS AND DISCUSSION

12. The main result was obtained as shown in figure 3 which shows the relational structure among descriptors after the final step of cards grouping. Five main categories were grouped and displayed in the diagram. The first and very important one was "Water quality and pollution problems" and it is believed to be a main theme in this connection. Other four categories are as follows : plan, policy, problems in hardware and problems in software. Three categories of planning, problems in hardware and problems in software are acting as causes of water quality and pollution problems while governmental policy in encouraging an increase in number of industries is also able to act as a cause without careful considerations of waste management. Plan concerned to water quality control should be produced under full

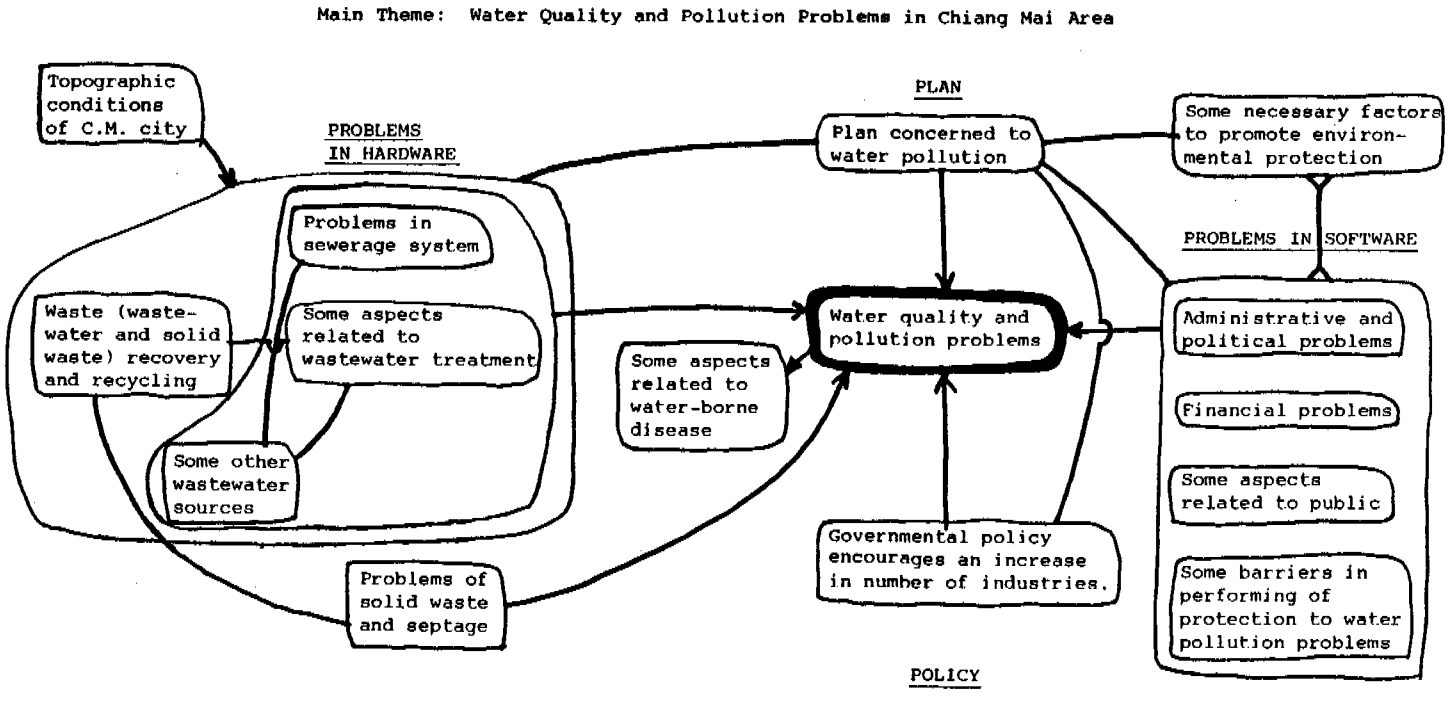

Fig. 3 Relational Structure of Categorized Information

Note: ——— : Related with, ⟶: Derived from, causal relation, and the details from the whole, ⟶⟵ : Mutually opposed or contradictory

consideration of other three categories. However, at present, the city have no proper plan and unfortunately very few discussion was done on planning and policy. Most of discussion time was used in the problems of software and hardware. As for problems in software, it can be clearly seen that administration, financials and public concerns are most important keywords. Problems in hardware were stressed in sewerage system, appropriate wastewater treatment, wastewater sources and reuse of wastes. Some useful informations can be extracted from discussions.

Current situation of water pollution

13. Water pollution were concentrated on both surface and groundwater. Mae Kha river, running through a high density area has the most serious problems in water quality. The second serious surface water is city canal, a famous historical monument and important stream from the view point of amenity. Ping river, a main stream in Chiangmai area, is also polluted. As for well water, the problem is serious. Bacterial density in the water is high through out the area. Taste and odour in well water, sometimes, was reported. Drinking water can not be declared hundred percent safe for human consumption. Water pollution problems, in the future, from chemicals such as fertilizer, pesticide and agricultural waste may be occurred. As for water-borne diseases, two kind of diseases were pointed. One is caused by pathogenic bacteria and acute in nature and the other may be caused by heavy metals and chronic. Denque fever was also mentioned as water related disease which are, at present, very wide spread in the area.

Problems in Hardware

14. Problem in sewerage system can be categorized into three items, namely no treatment facility, unsuitable sewer system and lack of maintenance. Collected sewage in many area were discharged directly to city canal and Mae Kha river without treatment. Many factories and newly built housing estate in the area were not equipped with treatment facilities. It was suggested that treatment system is necessary and preferably appropriate one should be considered. This is because of the high cost of conventional treatment process. Low cost technology such as oxidation pond, resource recovery type pond such as hyacinth pond were recommended. Separate collection system is also preferable. Other wastewater sources such as from gas station, laundries, hotels and night soil disposal were also created big problems. It should be urgently controlled.

15. Waste recovery and recycle was proposed as an aspect of wastewater treatment but careful evaluation should be considered.

16. Solid waste and septage are sometimes disposed to rivers directly or indirectly through sewer system. Suitable collection and disposal system of these wastes should be considered for environmental protection.

Problems in soft-ware

17. Administrative and political problems were grouped into four categorics related to organization, political aspect, administrator and politician. Lack of co-operation among organization involved in pollution problems were clearly pointed. Overlapse of duty among different agencies create this problems. There are also conflict between local and central governments. A new and powerful organization should be established for whole responsibilities of water problem. Administrators and politicians, usually, do not pay much attention to water pollution due to inadequate informations and lack of awareness of pollution problems. Public participation may be useful for improvement of these situations

18. Financial problems seem to be one of a major factors. However, concrete ideas and opinions were not proposed.

19. Public concerns play an important role in creating problems. The public has a habit to adapt the western style of living without modification such as water flush type toilet. The people who live in the community are selfish and intend to avoid rules and laws. This may be the case of lacking of environmental knowledges. There fore, social education should be emphasized. Education in environmental problems to pupils and students in school is also thought to be effective and significant.

20. Barriers in performing protection to water pollution problems were also pointed. Out-of-date law is one of the clearest example such as punishment fine has been established about 30 years ago and still using at present. Other barriers such as inadequate man power, loose action of government ant low priority of implementation for waste treatment must be also solved.

21. Some necessary factors to promote environmental protection were offered. It is first important to convince the attitudes of administrators and public that primary health care is important and then environmentist group should be organized. The implementation of water pollution control program should be then recommended and should be done gradually and increasingly.

CONCLUSIONS

22. The K-J method was applied to collect information, to consolidify facts, ideas and opinions related to water pollution problems in Chiangmai area. Current problems of water pollution were made clear to a certain degree. Hardware and software problems were fully discussed. Appropriate technolgoy seems to be a keywords of further research. Administration, organization public education must be emphasized and improved. Planning and policy should be made clear in the high level. From now, many discussions should be performed to make clear some special topics to realize countermeasures.

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Town planning and pollution control

Mansor Ibrahim, Ahmad Tajuddin Kechik and Amran Hamzah

INTRODUCTION

Urban planning concerns with allocation of completing land uses in urban areas. The location, pattern of development, urban form and lifestyle all have environmental implications (Figure 1). Control over environmental pollution can spread over a number of agencies and associated control authorities. It is this wide-ranging, diffuse and incomplete nature of pollution control which offers considerable opportunities for urban planning and pollution control (Wood, 1976).

ROLE OF TOWN PLANNER IN POLLUTION CONTROL

Planners can exert effective pollution control in the plan-making and development control stages. Land use planning - be it structure plans or local plans, and environmental planning are not only have similar process but they can be integrative (Figure 2). In determining the nature and location of development, renewal or redevelopment for instance, planners control over land use enable them to influence the spatial origin of wastes, pollution levels and distribution. Pollution arises from production and consumption activities; if the location of these activities is determined, the spatial distribution of waste generation can also be determined. Thus planners can control over the location of the pollution process.

Planners have three options in dealing with a polluting activity with respect to new development; granting permission unconditionally (yes) or with conditions (yes, but) or refusing permission (no). Locations at which power is generated, goods are produced and consumed and thus wastes occur can be regulated by granting or refusing planning permission. For example, by attaching conditions relating to the site and period of operation, planners can exercise indirect control over environmental noise level emission duration from a noisy activity.

Planners can grant or withhold planning permission or attach conditions to it whenever or wherever a proposed or existing source or pollution threatens its receptors and adjacent land use and activities. For example, a planner might refuse housing sited next to an airport, or that such potential resulting pollution and conflicting use be granted, provided there is adequate separation or buffer betweeen them. It is clear that planners themselves can control pollution at various stages in the pollution process vis-a-vis the plan making and development control stages through various land use techniques (Figure 3).

In conjunction with the planning approach, it is imperative that the legal and technological approaches are executed as well. The power is vested in the Town and Country Planning Act, 1976, the Local Government Act, 1974 as well as the Environmental Quantity Act, 1974.

COORDINATION AMONG ENVIRONMENTAL RELATED AGENCIES

Nevertheless, within the context of the institutional and administrative set up, planners are generally disposed to play a consultative as well as coordinating role in the control of pollution. In both plan making and development control, planners usually consult and coordinate efforts with other relevant agencies and authorities. For example, they might prepare an overview of pollution problems and invite other pollution control authorities to solve them in concert. Seemingly, there is ignorance about the precise scope of powers for pollution control and variation in practice exists in relation to planning process.

Besides that, there are lack of information and technical knowledge regarding urban planning and pollution control, the absence of specific pollution control standards and objectives, and the lack of consultation between planners and the relevant pollution control agencies. Such drawbacks, however, cannot negate the availability of various urban planning strategies and techniques to control pollutions (Wood, 1976).

As various organizational units are involved in overcoming and tackling pollution problems, effective coordination and integration among agencies are deemed

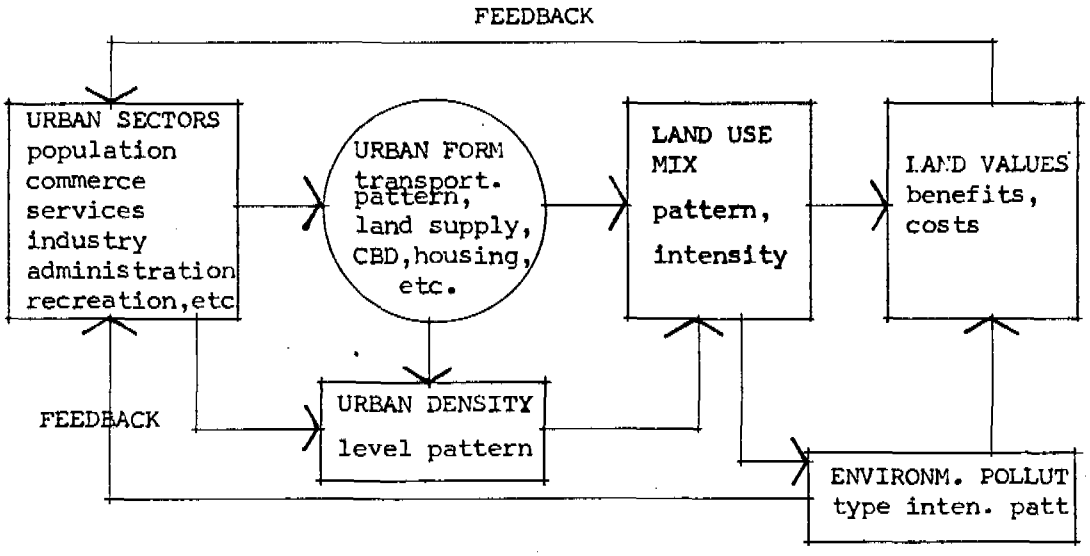

FIG. 1. URBAN LAND USE PLANNING AND ENVIRONMENTAL POLLUTION

Source: After Berry, et al. 1974

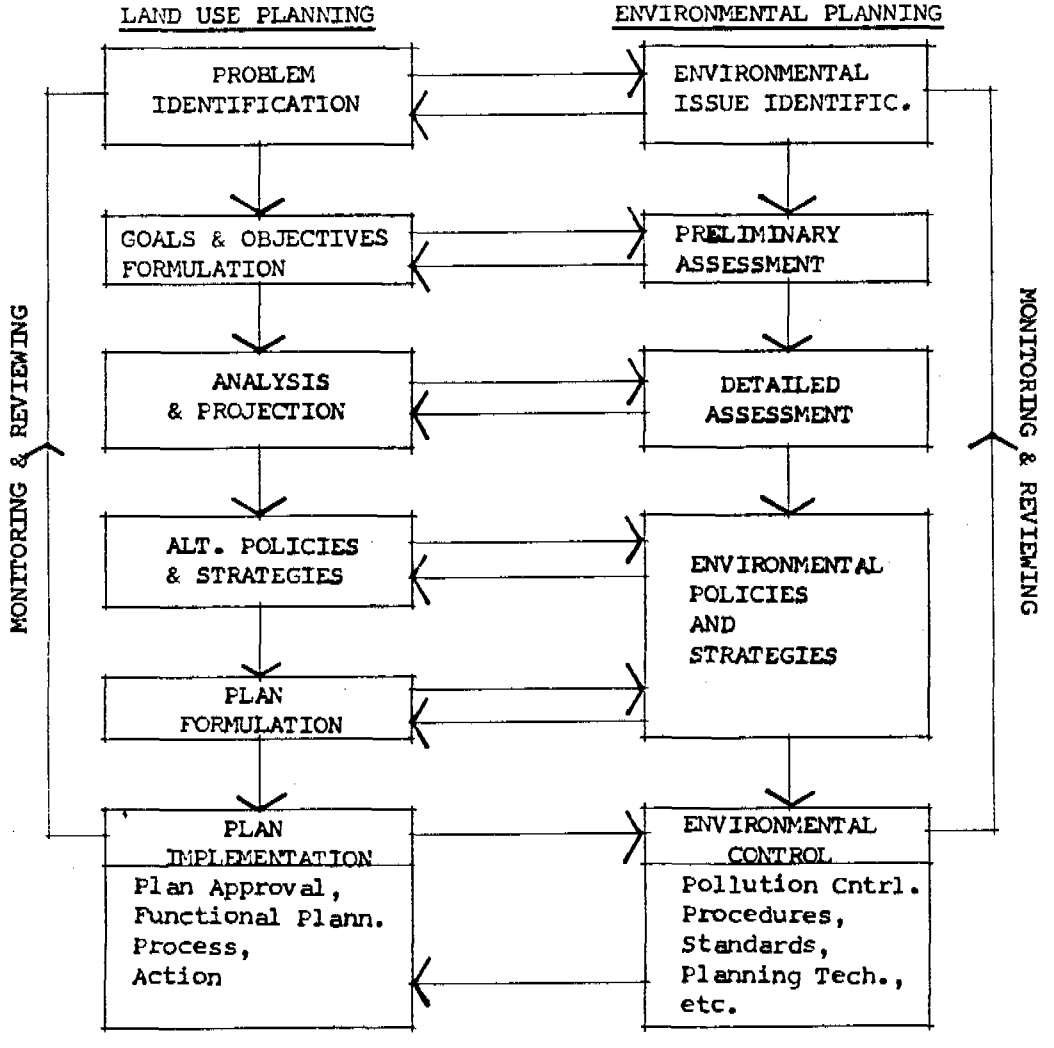

FIG. 2. LAND USE AND ENVIRONMENTAL PLANNING PROCESSES

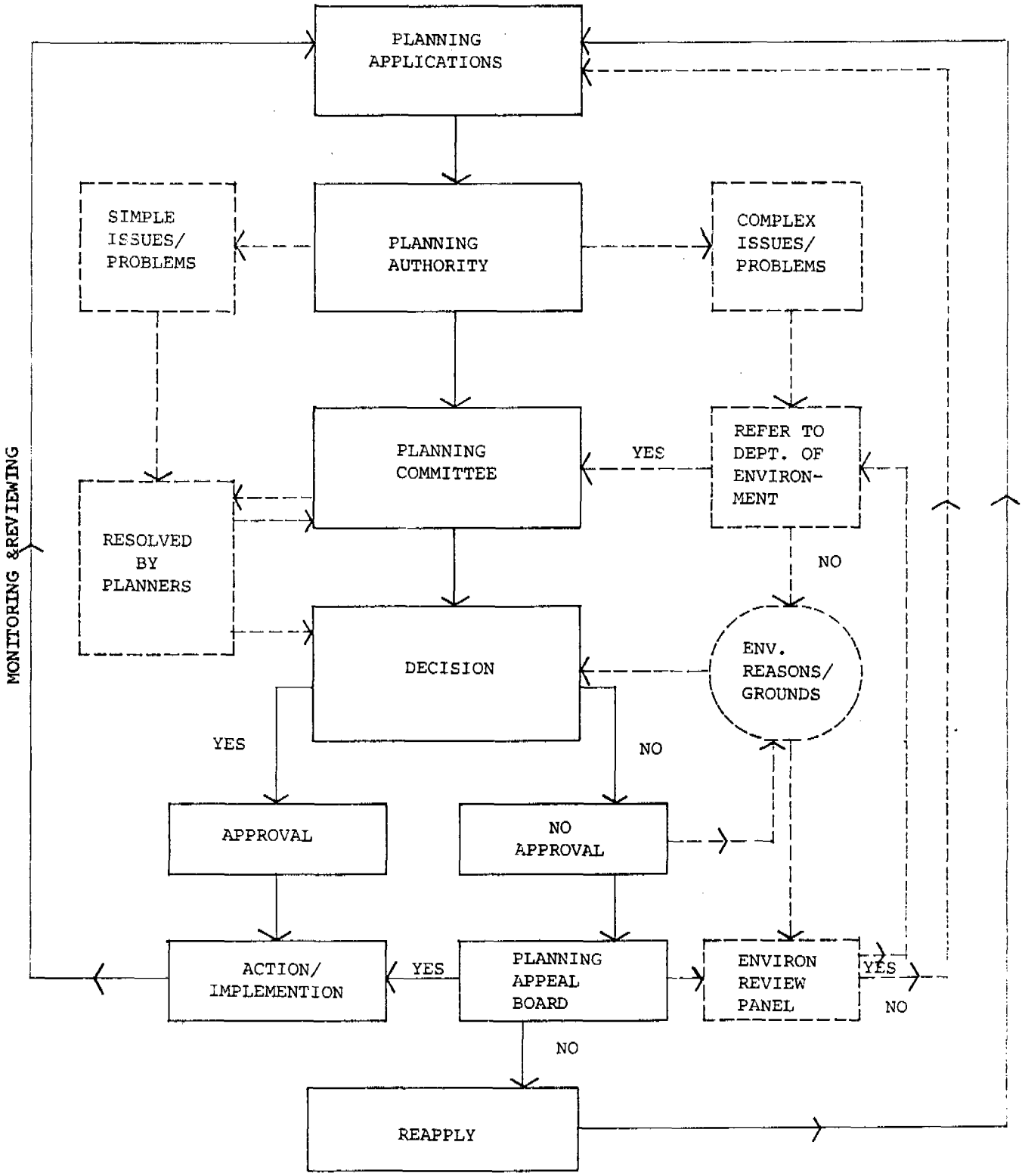

FIG. 3. POLLUTION CONTROL IN PLAN IMPLEMENTATION PROCESS

necessary (Mansor & Ahmad Tajuddin, 1987). Various options exist to overcome conflicts and jurisdictional encroachments among planning and pollution control authorities. The convention has always been through establishing working or joint committees between units and among levels of government. Other modes include improved information flows and communication, organisational restructuring or new arrangements. We also can make it mandatory for pollution controlling authorities to consult when potential polluting development proposals are envisaged. It is also proposed that developers be required to describe their development proposals and to incorporate pollution mitigating measures even in the plan making stage. This step is actually in line with the Department of Environment's formulation of the Environmental Impact Assessment Procedure (EIA).

CONCLUSION

The paper has briefly touched on the fact that planners do have a distinctive role in the control of all types of pollution. Ample planning powers and responsibilities relating to the control of pollution exist. There is a need to make planners aware of it. This might be met by such means as the Town and Country Planning Department and the Department of Environment circular on planning and pollution, pollution control manual, guidelines on planning techniques for pollution control; and perhaps more important is fuller coverage of the subject matter in planning education. The media should also disseminate and/or educate the general public on the issues.

Appropriate institution is also important in the environmental management process (Beale, 1980). It should involves a total commitment of all concerned parties to the environment viewed in its totality. The coordinated and integrated approaches must bring together governments at all levels, the private sector and the community at large. This should be coherently caterred for in any planning process.

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14th WEDC Conference

Water and urban services in Asia and the Pacific

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Bangkok's deteriorating groundwater - environmental issues

Chandran Nair

INTRODUCTION

Groundwater resources in the Bangkok Metropolitan area and surrounding provinces are being depleted and contaminated at alarming rates. They are highly vulnerable to excessive exploitation and quality deterioration associated with rapid industrial development and the resultant population growth. These factors coupled with the lack of effective accompanying controls have led to serious depletion of aquifers with subsequent environmental impacts. In addition to depletion this paper will also address the issue of quality deterioration which has roots both in over abstraction as well as in the lack of adequate pollution abatement measures. Both are interelated issues and can be linked to the lack of the practical application of water conservation and re-use strategies among the major industrial water users.

In observation wells water levels have dropped 10-12 m since 1985. Although the Groundwater Act was passed in 1978 restricting digging of wells it does not cover areas without municipal water and enforcement has been difficult. In some parts of the municipal area, there has been no development of surface resources and all the water is obtained from the ground.

GROUNDWATER IN BANGKOK

The Bangkok area is a metropolis consisting of the city of Bangkok and the surrounding districts of Thon Buri, Nonthaburi and Samut Prakarn with an area of about 750 km^2. The population of the metropolis is estimated to vary between 7-8 million. To serve this large population and the expanding industrial sector, water is drawn from both surface sources (Chao Phraya River) and groundwater reserves (increasingly in the last 15-20 yrs).

The groundwater underlying the area can be distinguished by 8 different aquifers.

1) Bangkok Aquifer which is the uppermost and extends to about 50 m. This aquifer can be tapped at 15 to 30 meters from the ground surface. It is however not used widely due to high salt levels.
2) Phra Pradeng Aquifer the top of which lies at about 60-80 m below groundlevel and is heavily used.
3) Nakhon Luang Aquifer which is at 100 to 140 m. below the ground and has a depth of 50 to 70 m. It is probably the most exploited aquifer for water supply in Bangkok.
4) Nonthaburi Aquifer which is very extensive and lies at a depth of 170 to 200 m below ground level. It has been used extensively by large consumers since deterioration in the above aquifers.

The deeper aquifers have not been used extensively. However there are some deep wells extracting water from the Sam Khoh aquifer at a depth of 250 m and located in the north of Nonthaburi and Pathum Thani. The other aquifers are: Phya Thai Aquifer (350 m zone), Thon Buri Aquifer (450 m zone), Pak Nam Aquifer (550 m zone)

The recharge to these aquifers by percolation is hindered by an impervious clay layer underlying the area. Therefore most recharge to the aquifer is essentially from lateral groundwater flow from the periphery of the Lower Central Plains. Groundwater recharge has also been reduced by the combined effects of an increased amount of paved area and pond eutrophication. Groundwater recharge is estimated annually at 3 percent of the mean annual rainfall of 1,191 mm. Due to this low level of recharge over abstraction above the safe yield has quickly led to overdraft.

The number of wells in each district in the metropolis and adjoining provinces was determined in a well inventory carried out 10 years ago. The survey established that for most of the wells surveyed the output could not be assessed since no information on rates and quantity of pumping is kept by the owners. This clearly demonstrates that actual abstraction rates are very approximate and that control on drilling and the monitoring of usage has not been a priority, a reflection of the administrative and planning problems. The Groundwater Act of 1987 has however required all well owners to register with the Groundwater Division of the Department of the Department of Mineral Resources. Areal distribution of private wells is shown in Table I "(ref. 1)".

The total groundwater extraction during 1979-1980 was estimated from the well inventory

Table 1 Areal Distribution of Private Wells as of January 1982 (Source: Department of Mineral Resources)

Usage / Area	Domestic	Industry/Factory	Agriculture	Total Number of Wells	Total Pumpage in m^3/day
	Number of Wells (Pumpage in m^3/day)	Number of Wells (Pumpage in m^3/day)	Number of Wells (Pumpage in m^3/day)		
Bangkok	3,353 (245,492)	1,838 (212,744)	100 (9,194)	5,291	467,430
Samut Prakan	1,478 (49,582)	1,392 (266,472)	103 (2,905)	2,973	318,959
Samut Sakhon	325 (4,779)	207 (30,594)	98 (2,741)	630	38,114
Nonthaburi	139 (27,738)	59 (14,000)	1 (10)	199	41,748
Pathum Thani	64 (5,372)	119 (72,986)	12 (307)	195	78,665
Ayutthaya	20 (597)	27 (2,601)	8 (344)	55	3,542
Total	5,379 (333,560)	3,642 (599,397)	322 (15,501)	9,343	948,458

to be over 1 million m^3/day. It is now estimated to be in excess of 1.5 million m^3/day although the Metropolitan Water Works Authority (MWWA) has considerably reduced its abstraction. The MWWA currently draws about 200,000 cu.m/day (7% of its total needs) from 50 deep wells. The MWWA plans to extend its service to the industrial districts of Paknam and Prapradaeng where groundwater depletion is a serious problem. The MWWA has an active program to stop abstraction by the year 1990.

The critical areas of groundwater exploitation include the administrative districts of Bangkapi, Phra Kanong and parts of Phra Pradaeng and Samut Prakarn. This area consumes about a half of all groundwater withdrawn. The central parts of Bangkok with the highest population consumes only a fourth of the total groundwater extracted. This is directly due to the fact that in the critical areas there is no public water supply while central Bangkok is fully covered.

CAUSES AND EFFECTS OF DETERIORATION

Having classified deterioration as a problem encompassing depletion and pollution we can now idetify the attributing causes. Excessive utilization coupled with poor controls has resulted in depletion. Depletion of reserves in turn has had different environmental impacts.

Subsidence

The most prominent environmental impact of groundwater depletion has been land subsidence on a large scale. Latest reports according to the Artesian Well Administration show that it has spread from Bangkok to the new industrial zones in Samut Sakhon, Ayutthaya and Chonburi. The cost in damage to buildings, roads, and drainage systems is considerable. The threat of floods increases everyear as large sections of the city sink and as existing storm drains become redundant especially when the level in the Chao Phya river is high. The maximum rate of subsidence in the metropolitan area has exceeded 10 cm/year in the period 1978-1979 and was as much as 1.14 metres between 1940-1980.

One of the major causes of ground surface subsidence is the result of cumulative compression of each soil layer due to pore water pressure drop in the layer. The uppermost clay layer in the Bangkok area is highly compressible and a large pore pressure drop in this layer will cause substancial compression. The rate of pore pressure drop in central Bangkok is larger than those observed in areas further away.

The ground surface elevation in the central part of Bangkok is about 1.0-1.5 m. above mean sea level (MSL), while it is only 0.4-1.0 m. above MSL in the critical areas. The result was severe flooding for a 2 month period in 1980 and floods of varying intensities every year.

Subsidence has created serious problems in the design, construction and maintenance of buildings, roads and bridges, drainage and sewage structures, water distribution systems, canals, conduits, pipelines and dock facilities. Negative skin friction on piles and settlement of pile foundations results from subsidence due to groundwater withdrawal. Large number of engineering structures which rest on deep foundations are found to stand up against the subsiding ground. The lowering of the ground surface with respect to sea level has caused a reduction in the hydraulic gradient for drainage and sewage systems resulting in serious threat of floods during high tide and also posing a health hazard as drains overflow into low lying areas. Subsidence has also caused damage to well casings and water transmission pipes that are connected to the pumping wells. Protrusion of well casings is common in subsidence areas,

an indication of land subsidence. The negative skin friction from the soil tends to compress the casing. The damaged casings and pipes have caused pollution to spread to lower aquifers further complicating efforts to control quality deterioration.

Water Quality

Groundwater pollution (quality deterioration) has usually four main origins: industrial, domestic, agricultural and environmental pollution. Each of these can be divided into continious and accidental types.

1) Industrial pollution is carried to the aquifer by:
   - Used water which contains chemical compounds and trace elements
   - Rain infiltration through waste disposal sites
   - Accidents, like the breaking of a pipe line
2) Domestic pollution is carried to the aquifer by:
   - Rain, infiltrating through sanitary landfills
   - Accidents, like the breaking of septic tanks
3) Agricultural pollution which is due to irrigation water or rain carrying away fertilisers, minerals, salts, herbicides and pesticides
4) Environmental pollution in mainly due to seawater intrusion in coastal aquifers.

Of the above the most serious threat to groundwater resources in Bangkok is that posed by seawater intrusion and is due to depletion. This quality deterioration is most obviously shown in the rise of salts such as Cl, Mg et. Salt water intrusion was not detected until 20 years ago. Since then many wells have been abandoned both by the MWWA and private well users. Numerous instances of industries being forced to abandon wells are on record and new wells are dug to tap water at greater depths. There is a great reluctance on the part of industries to switch to the MWWA supply where it has been made available for the simple reason that the pricing policy makes it economically sound to continue to use groundwater. It costs 1 Baht/m^3 (One pound sterling = 40 Baht) for groundwater as compared to 8 Baht/m^3 for the municipal equivalent. The rate of saltwater intrusion differs in various parts of the metropolis from 500 m per year in areas of heavy abstraction to 100 m per year in other areas. As water levels decline the rate of encroachment is expected to accelerate. The worst affected areas are the Phra Pradeng and Thon Buri areas.

There are also numerous cases of vertical leakages of salt water from upper aquifers to lower aquifers. This a problem in heavily industrialised areas where many wells operate in a small area and where the quality of well casings and maintenance is poor. Reliable information on the extent of intrusion is not known and this is especially true of the deeper aquifers due to the lack of data. Municipal wells used by the MWWA have shown five fold increases from levels of 200-250 mg/l to over 1,000 mg/l in a period of 15 years. In the Bangkok aquifer chloride contents range from 500 to several thousand mg/l.

Contamination of groundwater is also attributed to the corrosion of well casings or from imperfectly sealed wells. In areas of improper drainage and poor waste disposal the threat imposed by this form of groundwater contamination has not been adequately monitored or evaluated. Every time an area floods the potential for contamination via inadequately disposed industrial and domestic waste entering poorly sealed/cased wells is very high.

FACTORS CONTRIBUTING TO DETERIORATION

Solutions to the problem of groundwater deterioration and the resultant environmental impacts have been hampered by a number of factors including the lack of comprehensive and relevant legislation coupled with the inadequacies of coordinated efforts at various levels.

Inadequate legislation and tarrifs

Inadequate legislation has certainly been a stumbling block in efforts to curb over abstraction. Although laws prevent the drilling of wells in certain areas when old wells are abandoned implementation of this has been difficult.Conscientization of the general public and industrial management to the needs of water demand regulation is needed. This process should ideally go hand in hand with an integral set of laws, incentives, fiscal and other penalties (or tax reliefs), standards, and last but not least, there is the need to look at a tariff system for the consumption of water, commensurate with the amount of water withdrawn (used), the purpose for which it is used, and the degree of contamination it causes. If a progressive pricing system is socially and politically acceptable, and which means it can be enforced among the large amount of water consuming industries, it may become a major cause of water conservation, reuse and purification. It will certainly contribute to the cause of restoring peziometric levels.

In order to address the problem in this content we need to weigh social, economic and environmental factors and be prepared to make difficult trade offs in allocating limited resources to the solution of the problem. Attention has to be focussed upon the economic, management and public policy aspects of natural resource development and use. Overall institutional arrangements should serve to permit the implementation of economically efficient water quality management in the metropolitan area. Changes called for are therefore not just structural but also others such as public education and pricing which

seek to change peoples habits and consumption patterns.

Lack of Water reuse and conservation strategies

Lack of water reuse and conservation strategies in the industrial sector is a serious factor. Industrial wastewater reuse and water conservation should be employed as tools for pollution control and abatement and in this way help reduce groundwater abstraction. This type of conservation produces the benefits of less wastewater to be treated and a reduction in overall consumption, a dual strategy of water conservation and water resource recovery.

Many industrial water users (using groundwater) have very poor housekeeping practices due to the traditional belief that the water is free. Very often the first line of defence against waste, the metering of all water use is not employed. The need to re-use and conserve will be motivated by the pressures of limited water supply, poor water quality and other environmental considerations.

In view of current and prospective environmental standards, each industrial plant should ask itself which way is best to proceed to comply with regulatory demands. In considering the alternatives, there are really only two: no discharge, or discharge complying with current and future requirements of the regulatory agency. Where conditions may initially dictate treatment for discharges, the resulting effluent might be suitable for reuse within an industrial plant-either as cooling water and/or boiler feed make up. So why throw it away?

The burden of initiating these changes lies with the engineers and scientists, with assistance of the planners and decision makers. Rational water management in the metropolis needs a co-operative, multi disciplinary effort. Engineers, hydrologists, agronomists, ecologists, economists and sociologists have to act in conjunction with civil servants and corporate executives and politicians. Their objective must be to increase efficiency by re-use, re-cycling and conservation (reducing waste).

Other major factors contributing to deterioration are:-

- Lack of adequate alternative surface water sources, partly due to increased pollution of existing streams through industrial and municipal wastes as well as due to reasons of poor natural resource management (e.g. increasing silt levels and reduced stream flows)
- Absence of efforts towards large scale artifical recharge schemes
- Slow pace of industrial decentralization programme into regional centres
- Inadequate creation of industrial zones and estates where integration of reuse reclamation schemes into comprehensive water resources planning can be done with economic benefits.

CONCLUSION

The paper has attempted to link the current deterioration in groundwater quality to a variety of issues which highlight the need for greater attention to the environment in general. The future supply and demand as well as quality of water for the metropolis will be influenced by the trends and initiatives taken now to combat overuse and pollution. To succeed the goals should reflect the desires of an informed industrial sector and public.

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SESSION III
POLLUTION AND ITS CONTROL

Chairman: Dr Abu Bakar bin Jaafar
Department of Environment
Ministry of Science, Technology and Environment

PAPERS PRESENTED

L G HUTTON
Establishing environmental monitoring in Sri Lanka

Dr SUPORN KOOTTATEP and Dr KIYOSHI KAWAMURA
Information consolidation of pollution problems

MANSOR IBRAHIM, AHMAD TAJUDDIN KECHIK and AMRAN HAMZAH
Town planning and pollution control

CHANDRAN NAIR
Bangkok's deteriorating groundwater - environmental issues

DISCUSSION

L G HUTTON

1. Mr NEPAL wished to know if the laboratory was set up for regular monitoring of air, water and noise pollution.

2. Mr HUTTON replied that the laboratory was set up to support the NBRO Environmental Division with research and testing programmes. This included providing baseline data on the state of pollution of surface and groundwaters, air and noise. The water quality surveillance programme was an additional responsibility recently given by the Ministry of Local Government, Housing and Construction. This programme would involve some re-design of the operations and staffing of the laboratory.

3. Mr NEPAL asked if the results would be acted upon or would the laboratory treat them in a similar way to the ones from the Water Supply Board.

4. Mr HUTTON said that the surveillance programme results would be reported to the National Water Supply and Drainage Board, Ministry of Local Government Housing and Construction, Ministry of Health, National Health Coordinating Committee and the Interministerial Committee on the Environment. He assured Mr NEPAL that it would not be like the NWSDB laboratory. The wider reporting of the results would ensure that action would be taken. He suggested that Mr NEPAL should refer to the WHO Guidelines on Drinking Water Quality (1983) for details of the surveillance programmes.

5. Mr RICHARDSON wished to know if in addition to the annual review of environmental impact of a factory's operation when its factory licence was being renewed, there were standards set for discharge of effluent which gave the framework for monitoring and control between the annual licence reviews.

6. Mr HUTTON explained that standards were set for effluent quality as follows:
i. tolerance limits for industrial effluents discharged into inland surface waters (SLS 652:1984); and
ii. tolerance limits for industrial wastewater discharged into marine coastal waters (SLS 721:1985).
He said these standards had been reproduced together with the interim standards of CEA in Chapter 9 of Environmental Assessment Procedure for Development Activities in Urban Areas. A manual for planners and decision makers. NBRO Environmental Division, 99/1 Jawatte Road, Colombo 5. (Price US$25).

CHANDRAN NAIR

1. Mr ABHYANKAR asked if people and industries stopped using groundwater would MWWA have enough surface water to meet demands.

2. Mr NAIR explained that it was not clear but it appeared not. The plan, however, was not to completely stop using groundwater but to reduce it to levels compatible with recharge (about 0.8 million m^3/day). With increasing surface water deterioration it was unlikely that MWWA itself could tackle the issue which was one of regional water resource development (ie conservation, wastewater treatment etc).

3. Mr ABHYANKAR asked when MWWA was planning to discontinue the abstraction of groundwater (at present reported to be 7%).

4. Mr NAIR said the plan was to discontinue by 1990 but he thought this was unlikely.

5. Mr ABHYANKAR also asked what was the pricing policy for domestic and industrial users.

6. Mr NAIR explained that there was a differential pricing policy based on water consumption. For residential areas it varied from 4 to 7.65 Baht/m^3 and for industrial users, using more than 200 m^3/day it varied from 5 to 8.7 Baht/m^3.

7. Mr KOLSKY wished to know the safe yield of Bangkok's aquifer.

8. Mr NAIR said that based on several models studied over the years it was estimated to be in the region of 0.8 million m^3/day.

9. Mr KOLSKY noted that the paper called for economic pricing policies, but the costs of MWWA water appeared to be prohibitive relative to illegal tapping of the aquifer. If MWWA lowered its tariff, consumption would increase. If the price was increased, there would be even more illegal tapping. Pricing policy would be of little benefit as long as illegal tapping was permitted.

10. Mr NAIR replied that MWWA was attempting to lower prices in the critical industrial zones yet treatment and capital costs of the waterworks were increasing. The enforcement of existing regulations and the imposition of stricter controls in areas served by the MWWA was crucial (ie if it is supplied it must be used despite the presence of wells).

11. Mr NEPAL asked if the lowering of groundlevel in Bangkok was still continuing.

12. Mr NAIR said it was but in some areas it had been arrested as piezometric heads had been restored. In the worst areas it was still in the region of 10cm/year.

13. Mr NEPAL commented that with deteriorating groundwater quality treatment would be required. He asked if groundwater would still be available at Bh 3/m^3 if treated.

14. Mr NAIR explained that legislation did not permit the treatment of abstracted groundwater. Therefore if a user found the quality of groundwater to be unacceptable, by law he was not permitted to treat it in order to avoid drilling a new deeper well (if that was permissable) or paying a higher rate for the metropolitan water supply.

15. Mr NEPAL also commented that abstraction (about 2 million m^3/day) was more than the safe yield (0.5 million m^3/day). He said groundwater was being mined and asked how long this mining would continue.

16. Mr NAIR replied that mining was a continuing problem. In central Bangkok it had been arrested but in other areas it continued unabated. Until alternative supplies were provided in those areas not served by municipal supply mining would continue. The problem was central to the topic of depletion.

17. Mr RICHARDSON commented that charges levied by the Department of Mineral Resources were 1 Baht/m^3. O & M costs of an average well have been calculated at 1.5 to 2.0 Baht/m^3 giving a total cost of 2.5 to 3.0 Baht/m^3. He said alternative supply to groundwater was not available to many areas - eg Samutprakarn, where there were 2000 factories, nearly all were forced to use groundwater. MWWA was extending its service to these areas and had covenanted with its financiers (ADB) to enforce a switch to piped water when available. There were difficulties such as well licencing being for 10 years (in which time Bangkok could go down another meter), but the main requirement was political will.

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Kuala Lumpur 1988

Sewering two Asian cities

Geoffrey A Piggott

1. INTRODUCTION

Brunei Darussalam is a small country located on the north-western coast of the island of Borneo. Despite its small size (5765 km^2) and small population (227,000) it has one of the highest per capita incomes of any Asian country. The capital, Bandar Seri Begawan (originally called Brunei Town) and its urban area has a population of approximately 80,000 people and little industrial development. In 1966, proposals were developed to provide a conventional sewerage system to replace then existing sanitation methods including night-soil collection and septic tanks in the town centre and adjacent areas. The scheme was commissioned in 1971 and has since been extended and upgraded to serve new development. The Government have committed themselves to a high standard of public sanitation and have committed significant public expenditure on this and other sewerage schemes in Bandar Seri Begawan and other urban areas of Brunei. A rural sanitation study is currently in progress and proposals will be developed to upgrade sanitation using appropriate technology in these areas.

At the other extreme of the population and affluence spectra is the city of Shanghai in the People's Republic of China. Shanghai is China's and one of the world's most densely populated and heavily industrialised cities. It has a population of some 14 million people, 7 million of which reside in the city centre and fringe areas occupying an area of 300 km^2. Some 4000 significant industrial plants including chemical, petrochemical and heavy engineering complexes are located in the city. A combined sewerage network was constructed in the older parts of Shanghai in the 1920's and 30's and this system still operates today and presently collects the majority of mostly untreated industrial waste and a proportion of the domestic waste. The system discharges the raw, untreated wastewater to the Huangpu River and its tributaries within the city area via a large number of pumping stations and gravity outlets. Over the last 50 years or so, the water quality of the Huangpu and its tributaries has deteriorated significantly as a result of this inadequate treatment and disposal system. Severe constraints on funding in recent decades has meant that little was done about this major problem. However, since the early 1980's, a major liquid waste management strategy for Shanghai has evolved and is currently being implemented with loan assistance provided by the World Bank.

This paper will describe the approach taken to the development of modern collection, treatment and disposal systems for these two cities which are at opposite ends of the population and affluence spectra.

2. BANDAR SERI BEGAWAN - BRUNEI DARASSULAM

2.1 Historical Development of the Town Sewerage System

The town centre of Bandar Seri Begawan (BSB) consisting of shophouses, Government offices and housing was originally provided with a night soil collection system. As the city area grew, newer buildings were provided with septic tanks and in some cases with direct connection and discharge of untreated wastewater to monsoon drains and to the Sungai Brunei estuary (Fig.1). The low lying nature of the area in the town centre and unsuitable soil conditions meant that septic tank absorption systems were inappropriate; more often than not septic tank outlets were connected directly to monsoon drains. In addition to this onshore development there was and still is a large village known as Kampong Air adjacent to the town centre consisting of relatively low grade housing for about 20,000 people built on stilts over the waters of the Sungai Brunei and its tributaries. The village has been located in this position for centuries and is intimately connected with the Malay culture in Brunei and Borneo in general. Kampong Air has no liquid or solid waste sanitation facilities.

Grossly polluted surface water drains, odours, problems with the collection and disposal of nightsoil and health concerns led the Government in the mid 1960's to a decision to implement improved sanitation methods particularly for the town centre where significant new developments were planned. Consultants developed a conceptual design for a conventional separate system to collect toilet, sullage and trade waste for the town centre and the rapidly developing areas immediately to the north and west.

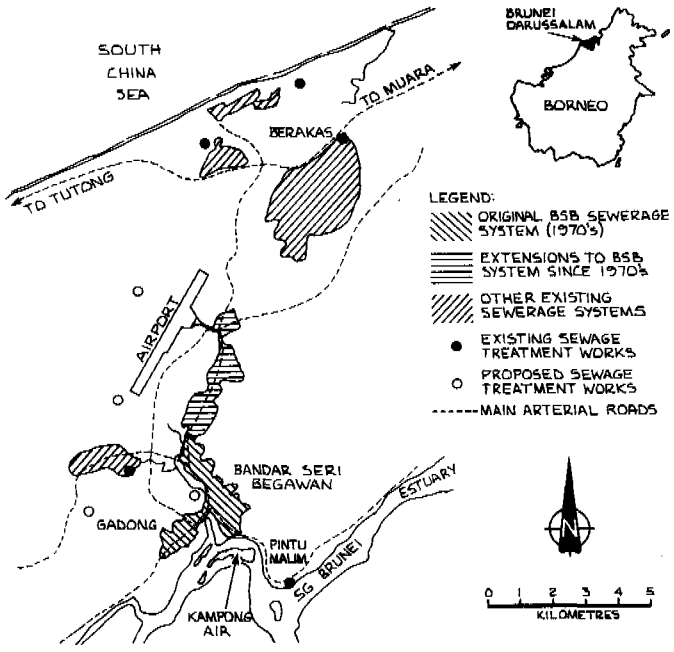

Figure 1

Septic tanks and on-site disposal had already proved inappropriate for the density of development and the soil conditions in the town area. Coupled with this was the Government's desire for a full sewerage system and its ability to fund it and other major public works projects via revenue from sales of oil and gas.

The original BSB sewerage scheme was designed for an ultimate 85,000 equivalent population (EP) based on a contributory Average Dry Weather Flow (ADWF) of 295 L/EP.d. The scheme was commissioned in 1971 (Ref 1) and consisted of 5 subcatchments each served by a wet well/dry well pumping station housing screenings comminutors and standby and duty electrically driven centrifugal pumps. Sewage from all sub-catchments drained to a terminal pumping station located just to the east of the town centre from where it was pumped via twin rising mains to the Pintu Malim sewage works located on the shores of the Sg Brunei, some 4km downstream of the town centre. The Pintu Malim sewage works provided primary treatment for a dry weather flow of 13.6 ML/d with the plant being designed to be doubled in capacity at a later date. Effluent was discharged via an outfall to the Sg Brunei estuary with raw sludge being stored and discharged on the ebbing tide via a separate small diameter outfall.

At the time of the development of the original BSB sewerage scheme, no steps were taken to provide sanitation facilities for Kampong Air as proposals at the time were to scale down the size of the village and to resettle its inhabitants in new onshore housing estates. Initial connections to the sewerage system were relatively slow and mainly consisted of Government offices, housing and shophouses. No legislative procedures were in place at the time to encourage private property owners to connect and inadequate septic tank and other systems continued to be utilised in some areas.

2.2 Extensions to the Original Sewerage Scheme

Considerable Government and private development has taken place during the 1980's along main arteries to the north and west of the town centre. The original scheme has been extended to serve these newer areas, resulting in three additional sub-catchments and associated pumping stations. Further connections have been provided in the older sub-catchments and very few unsewered properties now exist. The original sewerage system has in general performed satisfactorily; existing pumping stations have been mechanically and electrically upgraded and work is in hand to survey and repair isolated parts of the system which have suffered from corrosion.

The connected population of the BSB sewerage system is now approaching 30000EP. As such, action is in hand to increase the capacity of the Pintu Malim sewage works. Construction is presently underway on one additional circular primary sedimentation tank, anaerobic sludge digesters and dewatering facilities and improved administration and laboratory facilities. Treated and dewatered sludge will be disposed to a sanitary landfill.

2.3 Sungai Brunei Water Quality and Pollution Study

A baseline water quality and pollution study of the estuary was undertaken between 1984 and 1986. The estuary and its tributaries receive the majority of treated and untreated wastewater, septic tank effluent and polluted stormwater generated in Bandar Seri Begawan. The purpose of the study was to establish the existing physical, chemical and biological status of the estuary and to identify the sources and volumes of existing pollutants entering the estuary. A mixed segment computer model of estuary water quality was developed and was used to test future scenarios of wastewater management. The general need to control pollutant discharges was confirmed by monitoring and modelling. The study indicated that the current practice of the discharge of raw sludge from the Pintu Malim sewage works on the ebbing tide caused significant depressions in dissolved oxygen levels in the estuary particularly during periods of extended dry weather when estuary flushing was poor. This supported the decision to

implement sludge treatment, dewatering and offsite disposal at Pintu Malim. The study also indicated that the lack of liquid and solid waste sanitation facilities in Kampong Air contributed to high levels of bacterial contamination of the estuary near the city area, significantly reducing its amenity value.

2.4 New and Proposed Sewerage Schemes

Development has also taken place in the areas outside the catchment of the BSB town sewerage system. The Government has adopted a policy of providing conventional sewerage systems for areas where the density of development justifies it or where ground conditions are unsuitable for on-site disposal of septic tank effluent. Studies have been undertaken for the staged provision of sewerage to the Gadong area. Construction will soon commence on an oxidation ditch type sewage treatment works to serve new developments to the N-E. Sewerage schemes including treatment facilities to serve resettlement schemes and Government housing areas have recently been commissioned. Less densely populated development including ribbon development to the east of the town has been provided with septic tanks with on-site disposal. A waste management study for Kampong Air was conducted in 1986 (Ref 2). Proposals have been developed for the provision of a sewerage system using a combination of conventional gravity and vacuum sewers to serve the village and for wastes to be treated at the Pintu Malim sewage works and a new sewage works.

3. SHANGHAI - PEOPLE'S REPUBLIC OF CHINA

3.1 The Existing Wastewater Disposal System in Shanghai

The city of Shanghai is located on a flat delta plain area on the banks of the Huangpu River, a tributary of the Chang Jiang (Yangtze) estuary (Fig. 2). The Huangpu is the largest in a complex network of streams and canals which provide transport, water supply and waste disposal for the inhabitants of Shanghai. The Chang Jiang estuary dominates the water resources of the region and the complex hydraulics of the flat delta area.

Human domestic waste disposal is centred on the nightsoil system with collected wastes being transported by barge or truck to the countryside, treated with lime and used as a fertilizer/soil conditioner. In redevelopments within the city such as apartments blocks, septic tank systems are utilised and new developments on the urban fringes are fully sewered.

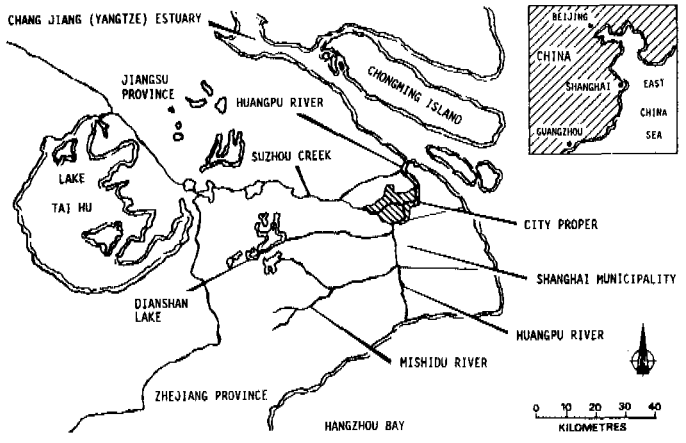

Figure 2

Within the city area, the main drainage system is an interconnected combined sewerage reticulation network which receives industrial and domestic wastes (except for nightsoil and septic tank sludges) as well as stormwater. The system was mostly constructed in the 1920's and 1930's. Subsidence in the city area due to groundwater overpumping and the occasional occurrence of typhoon induced storm surges has necessitated the construction of flood walls along the main rivers and sluice gates on tributary creeks. There are two existing interceptors which carry about 45% of the dry weather flow away from the city and discharges it on the shores of the Chang Jiang with adverse environmental consequences. The remaining 55% of the dry weather flow and the majority of wet weather flows are discharged from the combined sewerage system to the Huangpu and its tributaries under gravity and by pumping when tidal levels and/or flows are high. About 60% of the 4000 significant factories discharge their wastewater, either untreated or partially treated, into the combined sewerage system with the remainder being discharged directly into the Huangpu or its tributaries. The total untreated domestic and industrial wastewater flow entering the Huangpu in the urban area is 1000 ML/d conveying a load of 210 tonnes per day BOD_5. Flows and loads are expected to increase by 80% and 50% respectively by the year 2000 in the absence of any measures to control pollution. The poor quality of the Huangpu and its tributaries is evidenced by the results of regular water quality surveys which indicate low or zero Dissolved Oxygen (DO) levels in the urban area.

3.2 Tackling an Immense Pollution Problem

The Shanghai Municipal Government have adopted the long term goal of achieving the National Water Quality Standards for surface waters. This implies achieving minimum DO levels of 4 and 6 mg/L respectively in the city centre and the upstream reaches of the

Huangpu and its tributaries. With the recent availability of fertilisers at a reasonable cost, there is no longer the desire of farmers to utilise nightsoil for agricultural purposes. This combined with increasing cartage costs and health problems has meant that eventually this system of domestic wastewater disposal will no longer be acceptable in Shanghai.

During 1982 and 1983, agreement was reached between the Chinese Government, the World Bank and the Australian International Development Assistance Bureau (AIDAB) to undertake a major study into liquid waste management in Shanghai. During 1983 and 1984, a strategy was developed by engineers, scientists and other technical staff of various Shanghai Government agencies with the assistance of Australian consultants funded by AIDAB.

Once the present and future wastewater flows and loads were estimated, a mixed segment tidal computer model was used to establish that in order to meet the long-term water quality objectives, more than 90% of present and projected future pollutant loads would need to be removed from the river system. At the very outset of the study and given the very dense population and development it soon became apparent that some form of conventional sewerage system involving collection, conveyance, treatment and disposal would be required. An early decision was also made in principle, mainly on the basis of replacement cost and despite some disadvantages, to retain the combined sewerage system. As the combined sewerage system has a limited hydraulic capacity it was necessary to accept that overflows to waterways would always occur after heavy rain. Modelling was carried out to determine acceptable levels of overflow to attain the water quality objectives.

A wide range of conveyance, treatment and disposal options were developed and systematically analysed to identify the least cost alternative. All viable options required basic on-site pretreatment of industrial wastes.

The adopted least cost and environmentally acceptable strategy was a two stage attainment of water quality objectives using preliminary treatment and deepwater disposal in the Chang Jiang estuary. An investigation of appropriate outfall sites along the Chang Jiang estuary was used to refine the overall strategy. The two stage strategy involving the physical components of the scheme, financial components (adoption of "user pays" principles) and institutional components (establishment of a new self funding sewerage authority for Shanghai, training of staff at all levels) was adopted in principle by the Shanghai Government, World Bank and AIDAB in 1985. The sheer size of the project required a two stage implementation. Stage 1, which is to be implemented immediately will deal with the most heavily polluted areas.

3.3 Preliminary Design, Foreign Exchange Funding and Current Status

Preliminary design of the Stage 1 project was carried out during 1985/6 by a team of some 70 Chinese engineers with the continued assistance of the AIDAB consultants. A description of the preliminary design is contained in Ref 3. World Bank appraisal of the preliminary design, financial and institutional proposals took place in late 1986, resulting in approval of a US$145M loan to cover the majority of the foreign exchange component of the US$430M project. Work is currently being undertaken on the detail design and documentation of the project by various Shanghai engineering design institutes on behalf of the newly formed Shanghai Sewerage Project Construction Company. SSPCC is being advised by Binnie and Partners Pty Ltd, Australia, on technical and project management issues. The Stage 1 project is expected to be commissioned by 1992/3.

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14th WEDC Conference

Water and urban services
In Asia and the Pacific

Kuala Lumpur 1988

Low cost latrine emptying vehicle

Manus Coffey

The 1980's were designated as the decade of water and sanitation. In many situations, water borne sanitation is inappropriate due to the high costs involved and inadequate supplies of water and a number of United Nations and international aid organisations have been working on improved methods of "on site" sanitation including improved designs of pit latrine.

In the urban areas of the low income countries, and in particular in the un-planned or "peri-urban" areas, land is frequently so scarce that the houses and access roads will take up every inch of space available. These areas frequently develop on low lying or steep land which is unsuitable for the normal expansion of the city, and in these areas in particular there are serious problems when latrines become filled or back up during the wet seasons. Effluent can spread during flooding or is washed down the slopes on to the houses below carrying the organisms which are responsible for many of the endemic diseases.

Efficient and hygenic systems are needed for emptying the pit latrines in such areas where access is frequently extremely difficult and these are the very communities which can least afford high cost solutions.

The density of the wastes in pit latrines will increase with time as the solid materials settle out and the organic material breaks down. This sedimentation is relatively insignificant during the first year or so and such wastes can be handled by conventional vacuum tanker vehicles, but in time these wastes will increase in density and develop a greater resistance to flow.

In 1981 the IRCWD, (The International Reference Centre for Wastes Disposal), initiated a project to study the problems of emptying pits with dense sludges. This study in turn led to the setting up of a test programme to assess the efficiency of different systems in the field.

In 1983 tests were carried out in Botswana on machines from a number of different countries to identify the problems of sucking out the dense wastes found in latrine pits, and to find an appropriate solution. Prototype machines were provided by the British ODA, the Swedish SIDA and private industry in a number of countries, These included conventional low powered vacuum tankers, high powered vacuum tankers with liquid ring and sliding vane pumps, remote suction systems and manually operated diaphragm pumps. The results of these tests have been published by the I.R.C.W.D.

The Botswana tests showed that conventional vacuum tankers with low powered vacuum pumps were incapable of sucking out the dense wastes found in the pit latrines. These wastes are relatively easy to suck to start with, but become more dense and thixotropic with time, so that the longer the pit has been left unserviced the more difficult it becomes to empty. Large and very powerful tankers fitted with very high capacity vacuum pumps using "air drag" or "plug and drag" techniques can suck these wastes, but such vehicles are very costly and the performance of these machines is greatly reduced where long hose lengths are required, and the maximum depth to which they can operate is determined by the height between the sludge in the pit and the top of the sludge in the vehicle tank.

As can be expected, the Botswana tests showed that the more powerful the vacuum pump on any vehicle, the better it was able to suck dense wastes and a lot of information was collected on the effects of different air flows, hose lengths and hose sizes on the suction performance with wastes of varying densities.

High powered pumps require high powered engines to drive them so the pumps and engines are heavy and need to be mounted on large trucks taking up a high proportion of the trucks load capacity. This in turn means that they are costly to buy, to run and to maintain, and due to their size, they have poor manouverability so that they cannot be positioned close to the pits in areas with difficult access.

Thus they require long hose lengths with a lot of bends which in turn increases the friction in the suction pipes. Large vehicles also have large wheels with high chassis and high overall heights restricting access, but more importantly, the increased height of the sludge above ground level dictates the maximum depths which can be pumped as well as making it more difficult to connect and disconnect the hoses.

Thus it can be seen that such high powered vacuum tankers are self defeating. The conditions in Botswana were comparatively easy with good access in most cases compared to many other developing countries, but the tests demonstrated that large tankers cannot reach into areas where there are narrow and unplanned roads with poor surfaces and steep slopes. In any case they are far too costly to be appropriate in the poorer countries where the problems are greatest.

The need was identified for a low cost vehicle with a high capacity vacuum pump which could manouver into the difficult areas; could get right up to the pit latrine so that very short hose lengths could be used, had a low tank height so that it could service deep pits and had the least possible capital, maintenance and running costs so that it could be affordable by low income countries.

Our company had been working on similar problems in the hard to service areas of Trinidad and we were approached by Mr. Jim Wilson, Sanitation Advisor to the World Bank and United Nations Development Programme Technology Advisory Group in East Africa. We were asked to study the results of the tests in Botswana, and the problems of the large cities and small towns in Africa and other parts of the world, and put forward proposals for an appropriate latrine and septic tank emptying vehicle.

Our studies, funded by the Irish Government, included visits to the unplanned or "peri-urban" areas of a number of African cities as well as small towns in coastal, mountain, and desert areas. These studies included an analysis of the servicing facilities available within these countries to make sure that as many components as possible were used with existing spares and service support. We searched all over the world to see if we could find a suitable vehicle chassis on which to base an appropriate vacuum tanker without success so we designed a dedicated chassis and tanker.

Previous studies carried out on behalf of the World Bank have shown that in low and medium income countries, the greatest cost factor in operating vehicles is invariably the depreciation costs of the vehicles and the interest on the capital employed. There are standard depreciation rates which are normally accepted as the economic life, or write off period, of any vehicle and in the industrialised countries trucks are normally depreciated over seven years whereas tractors will be depreciated over ten years. (Of course it is common to see vehicles on the roads which are much older than this but maintenance and running costs increase with age and it is important to distinguish between the economic life and the actual life of any vehicle).

The increased life of the tractor, when compared with a truck, is due to the lower engine speed. (Typically 2,200 rpm for the tractor compared with up to 5,000 rpm for the truck) and a lower road speed which requires a more simple construction and reduces wear on all the moving parts. For this reason it was decided to design a vehicle with a low engine speed and reduced road speed which would have the life expectation of a tractor, and to keep this vehicle as simple as possible for ease of maintenance with the minimum number of moving parts. Thus we would have a long life vehicle with a minimum purchase cost and correspondingly reduced running and depreciation costs.

The capital cost of any vehicle is determined to a large extent by the power and speed of the engine which in turn dictates the strength and type of gearbox, clutch and drive axle used. Modern trucks are designed for high road speeds and require high power to weight ratios but by reducing the top speed and acceleration it is possible to use much lower powered engines and much more basic transmissions.

A typical modern motor car will have a power to weight ratio of around 45 Kw/ton and a modern truck will have a ratio of around 7.5 Kw/ton. However, until only a few years ago trucks were commonly around 5 Kw/ton and their performance was considered adequate. By reducing the top speed, we can accept a figure of around 4 Kw/ton which is roughly equivalent to a farm tractor pulling a loaded trailer.

By using a reduced road speed we can design a vehicle with a high proportion of its weight on the driving wheels to give it the traction to enable it to travel on soft or steep tracks. (A conventional truck,

unladen, may have as little as 30% of its weight on the driving wheels compared with 60% for a tractor, and this, more than the wheel size determines its off road capability).

We were also able to design a vehicle using a rigid beam front axle with a centre pivot. This axle arrangement is commonly used on tractors, construction dumper trucks and other such vehicles and is perfectly satisfactory at the lower speeds involved. It avoids all the problems of a vehicle with suspension systems where torsional loads are transmitted to the chassis and there are considerable numbers of moving parts and linkages, all of which will eventually wear, accounting for the high proportion of vehicles maintenance which is related to the front suspension and steering.

We chose the Lister air cooled engine for reliability and its widespread service back up all over the developing countries. However some countries may have a preference for different engines so we designed a vehicle which can be fitted with a variety of different engines. (In Egypt for example the German Deutz engine is manufactured locally and the vehicle can be adapted to fit this engine).

We studied the different vacuum pumps available and chose a sliding vane pump with a capacity of 9,000 litres/minute. The particular pump chosen is fan cooled to give a long life in tropical countries without the additional costs and complexity of water cooled or liquid ring pumps. We also included a cyclonic separator and grit strainer between the tank and the pump to protect the pump from wear.

The prototype vacuum tank held 1,600 litres of sludge, (although we will increase this to 2000 litres for future vehicles), and a separate tank provides 200 litres of water to a high pressure pump for fluidising very dense wastes and for washing down the vehicles and the latrine area.

The size of the vehicle was determined by the capacity of the vacuum pump necessary to give a good suction performance. This in turn determined the engine power required and the maximum all up weight of the vehicle allowing for a suitable power to weight ratio for adequate road performance.

Four,6 metre lengths of 100mm bore hose can be carried on the truck with quick release couplings to join them as required, (although for most applications it was found that only one hose was required). These hoses can be used for both sucking up the wastes and for discharging them in situations where the truck cannot reach right up to the discharge area. Seperate inlet and discharge valves allow the vehicle to be used as a stationary pump for emptying large septic tanks and pumping the sludge considerable distances.

This is achieved by alternatively evacuating and then pressurising the tank to a pressure of 1.0 bar. A 200mm discharge valve is also provided for fast discharging directly into a sewerage treatment plant and for cleaning out the tank.

The complete tanker is less than 4 metres long and only 1.6 metres wide, about the same dimensions as a small motor car, and it has a turning radius of less than 5 metres. Seats are provided for the driver and two additional crew.

The first vehicle was purchased by the Norwegian Aid Organisation NORAD and air-freighted to Kenya in time for the African Water Technology Conference in Nairobi last year. Since then it has been undergoing continuous testing under a variety of different conditions. These tests have demonstrated that a vehicle, which can be manufactured for less than one third the cost of a conventional vacuum tanker, can reach into areas which could not be serviced in the past, and can service latrines with dense wastes at depths which have not been possible previously at an affordable cost.

Running and maintenance costs were found to be remarkably low and, during one three week period for example, in a small town in Kenya, the tanker was able to collect an average of 33 loads, or more than 53 cubic metres, of wastes per day. The haul distance in this case was about 1/2 Km from the collection to the discharge area and the average fuel consumption was only 6.7 litres of diesel oil per day.

The costs of the fuel, and all other running costs apart from labour during this three week period worked out at just US$ 0.12 per cubic metre of wastes collected. Even taking labour and depreciation into account, the costs of operating this tanker amount to only a small fraction of those of conventional tankers.

Although the road speed of this vehicle is restricted to 30 km/hr, it has been found that this limited speed is more than compensated for by the very fast turn around times which can be achieved due to the

extreme manouverability and the very short set up, suck out and clean down times due to the short lengths of hose used and the very low tank height.

The relatively high pump capacity, combined with the smaller tank give a very fast "gulping" rate for"plug and drag" operation. In this application the hose is submerged in the wastes until it blocks and a high vacuum has built up in the tank. The hose is then pulled back by hand to allow a "gulp" of air to "drag" the "plug" of wastes into the tank. In practice the gulping rate is dictated by the workers as it is extremely heavy work to pull back the hose against the combined load of the hose,the sludge in the hose and the suction forces.

For this reason we are developing a "gulping attachment" which uses a vacuum cylinder to automatically lift the suction hose as soon as the vacuum in the tank has built up to a pre-determined level. It remains to be seen how successful this system can be in practice, but it has performed very well in simulated tests in our workshop and it is a very low cost attachment

Wherever there are problems with latrine waste there are almost invariably also problems with solid wastes, refuse or garbage, and these are the wastes which harbour the rodents and insects which are responsible for spreading many of the endemic diseases which originate from the faecal wastes.

In the majority of cases the most economical collection system will use small communal containers which can be deposited within easy reach of each household where the inhabitants will deposit their wastes. A small container handling vehicle can then pick up these containers and transport them to the dumping area, or where haul distances are long, to an access point where they can be transfered to a conventional tuck for hauling away for emptying.

As there is no suitable vehicle available in the world for this purpose which can reach into the peri-urban areas at an affordable cost, we are developing a very simple vehicles which uses the same basic chassis as the latrine emptying vehicle for this purpose.

Where door to door collection is required, or vehicles are needed which can collect the waste from communal compounds or can collect the heaps of wastes commonly found around the peri-urban areas, a simple tipping body can be fitted to the same chassis.

The vacuum tanker, container pick up system and the tipping truck, all based on a common chassis, can thus provide an integrated and affordable waste handling system for small towns, congested city centre areas and the unplanned peri-urban areas of developing countries all over the world.

In Conclusion:-

Following the work which had been carried out to identify the problems of servicing pit latrines and septic tanks in low and medium income countries, we were asked to draw up the specification for a suitable vacuum tanker vehicle.

We started out by trying to find a suitable vehicle chassis on which we could mount a high powered vacuum tanker for handling the dense latrine wastes found in the more difficult areas of developing countries. When we could not find a suitable chassis at an affordable cost, we designed a dedicated vehicle on which we could build the vacuum tanker.

The tests which have been carried out to date have shown that a highly manouverable vehicle which can reach right up to the pit is able to achieve very high collection rates at a much lower cost than conventional vacuum tankers and can be an appropriate solution to the problems of the small towns as well as the difficult areas of the larger cities.

Our work in this field has highlighted further problems relating to the handling of solid wastes in developing countries where, once again, there is no appropriate or affordable solution.

Both liquid and solid waste handling problems centre around the need for a transport vehicle with low purchase, running and maintenance costs, which has the manouver-ability and traction to enable it to travel on narrow and steep tracks and over soft ground where conventional vehicles cannot reach. Previous attempts to solve these problems have all concentrated on the conventional truck chassis with its high cost, relatively short life, high fuel consumption and limitations which are an inherent feature of vehicles which are designed for high speeds and long hauls on good roads instead of a vehicle designed for lower speeds and shorter hauls on the bad roads commonly found in urban and peri-urban situations.

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Water and urban services in Asia and the Pacific

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Behaviour of Klang Hospital ponds

Fadil Haji Othman

Introduction

Klang Valley is the most urbanized, industrilized and populous region in Malaysia. It is due to the fact that Kuala Lumpur, the Capital City of Malaysia, is located in this region. The Region which is undulating with low hills, consists of areas under the Federal Territory (Kuala Lumpur), and four districts of Darul Ehsan Selangor State, namely Gombak, Hulu Langat, Kelang and Petaling. Fig. 1 shows the location of the valley. It is the centre of the economic activities in Malaysia.

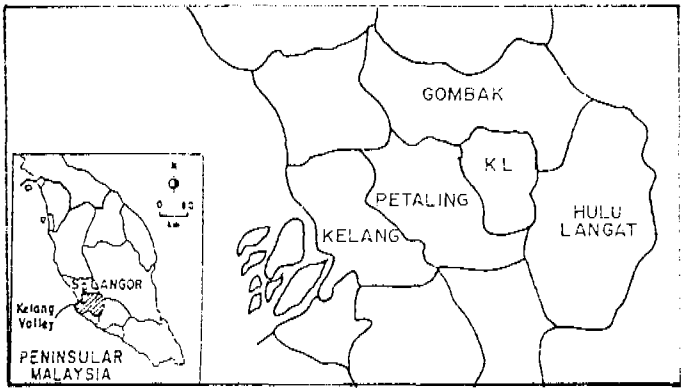

Fig. 1 : Location of Klang Valley

The Malaysian Government is firm in its policy of maintaining clean and healthy living environment. Under the existing laws, such as Local Government Act, the Local Authorities are responsible for maintaining clean urban centres. They are empowered to make by-laws for execution of of its functions.

Table 1 shows the refuse management in the valley, and the responsible authorities for refuse management is shown Table 2. A typical physical composition of refuse in Klang Valley is represented in Table 3.

At present, refuse from residential areas are collected once in every two days, while wastes from commercial centres are collected daily. For a house to house collection service, refuse is placed by the homeowner in a 100 - 120 litres container which is located outside homeowner's property. In high-rise apartment buildings or congested residential areas, refuses usually bagged, are placed by the tenants in a comman storage container. Its size may vary from 1 - 12 cu m. For office and commercial

Table 1: Klang Valley Refuse management

	Kuala Lumpur	Gombak	Hulu Langat	Kelang	Petaling	
Area (Sq.Km)	243.5	652.7	828.8	629.4	486.9	2,841.3
Population(1000) (1985)	1,103.2	205	217.4	341.8	436.72	2,304.1
Pop. Rate (%)	2.1	2.8	2.6	2.6	2.4	Av.=2.5
Urban Centre	7	7	9	3	7	33
Collected Refuse (ton/day)	2,000	395	119	350	413	3,277
Existing disposal Sites	2	5	4	2	5	18
Area of disposal Site (ha)	12	10	-	-	18	-
Cost US$/cap/month*	1.13	1.25	1.04	0.92	0.23	Av.=0.92 (1977)
Cost US$/ton(1976)*	34.0	-	-	-	23.75	Av.=12.5
Disposal methods	Modf. landfill	open dump + land fill	open dump + land fill	open dump + land fill	open dump + land fill	

* Adapted from Abu Bakar, 1978.

areas, individual office or commercial centre is responsible to put their refuse in a large storage container with size of 12 cu m. For industrial wastes, it is the responsibility of individual industry, however, they are accepted for disposal at the Local Authority landfill.

In general, there is no onsite handling except for a certain case such as at a newly constructed high-rise building where refuse is placed in a comman large container equiped with a compactor in order to reduce the refuse volume. It is a comman practice that during collection, sorting is done mannually by the crew for usable material recovery, such as glass bottles, paper, cardboard, plastic and aluminium cans.

Refuse containers are usually picked up mannually or mechanically, depend on the container sizes and the types of collection system. For hauled container system which the container size is large, usually 12 cu m, the container is picked up mechanically by a roll-on-roll-off vehicle. Small size containers, about 100 litres in size, are picked up mannually and the containers for stationary container system with size of 1 - 2 cu. m. are picked up mechanically.

In most cases, the collection services are carried out by the local authority staff. However, there are contracted private companies collect refuse from certain areas which are under local government responsibility. Usually three or four crews are assigned for each collection vehicle.

Refuse management problems of the valley have reached an acute level and needed an urgent action for planning, designing and implementation. The most pressing problem is to find alternative for the disposal with an acceptable manner, taking into consideration health and environmental factors and the economic viability of the various alternatives. Those problems are closely related to the shortage of adequate funds, manpower, lack of good management system and expertise (Pillay, 1986). However, civic attitudes of the public could help the effort to improve the refuse management.

Table 2: Responsible Authorities on Refuse Management in Klang Valley

District	Area	Administrative Organization	Department in charge
Kuala Lumpur	the whole K.L area	City Hall	Urban Service Department
Petaling	Petaling Jaya Municipality	PJ Municipal Council	Urban Service Department
	Shah Alam Municipality	Shah Alam Municipal Council	Health Department
	Others	Petaling District Council	Health Department
Gombak	All Areas	Gombak District Council	Health Department
Hulu Langat	All Areas	Hulu Langat District Council	Health Department
Kelang	Kelang Municipality	Kelang Municipal Council	Health Department
	Others	Kelang District Council	Health Department

Table 3: A Typical Physical Characteristic Of Refuse In Klang Valley

Component (% W)	Kuala Lumpur	Kelang
Food Waste	51	44
Paper & Cardboard	28	27
Plastic	8	8
Textiles 2	3	
Wood & Garden Trimming	3	10
Glass	3	3
Metal	5	3
Density kg/m^3	285.8	203.1

Source: Department of Environment, Malaysia.

Collection Analysis

Collection has been the costliest aspects of all. It is estimated to be 60 to 80 percent of the total cost (Tchobanoglous, 1977). Therefore it is the intention of the study, that the collection operation in Klang Valley should be analyzed, hopefully it would be useful for improving the collection system.

Collection time is an important factor that can be used to quantify the collection operation. A simple definition of the collection time, mathermatically is

$$T = \frac{P + h + s}{1 - w} \quad \ldots\ldots(1)$$

where T is collection time per trip, p is pickup time per trip, h is haul time per trip, s is at-site time per trip and w is off-route factor which is expressed as a fraction (Tchobanoglous, 1977). For hauled container systems operated in the conventional mode, pickup time refers to the time spent driving to the next container after an empty container has been deposited, the spent picking up the loaded container, and the time required to redeposited the container after its contents have been emptied. For hauled container systems operated in the exchange-container mode, pickup includes the time required to pick up a loaded container and to redeposit the container at the next location after its contents have been emptied (Tchobanaglous, 1977). Haul time refers to the time required to reach the disposal site and at-site time is the unit operation which refers to the time spent at the disposal site and includes the time spent waiting to unload as well as the time spent unloading.

The haul time depends on both haul speed and distance. It has been found that haul time may be defined as

$$h = a + bx \quad \ldots\ldots\ldots\ldots(2)$$

where a and b are empirical constants; a is in h/trip; and b is in h/km (Tchobanaglous, 1977),

The unit operation off-route (w) includes all time spent on activities that are nonproductive from the point of view of the overall collection operation. It may include the time lost due to unavoidable congestion, time spent on equipment repairs and maintenance, time spent for lunch in excess of the stated lunch period, time spent checking in and out in the morning and at the end of the day.

In this study, all the times and distance of a collection vehicle were recorded. By substituting the data into equations (1) and (2), the values of a, b and w are found out. The value of w determines the efficiency of the collection operation.

Results and Discussion

Some of the refuse collection facilities used in Klang Valley is shown as in Table 4.

The result of the study carried out in three areas of the valley, Kuala Lumpur, Gombak and Petaling Jaya Municipality, is shown in Table 5.

A typical relation between haul-time and distance is shown in Fig. 2. The value of "a" was found from the intersection of the line and the haul-time axis, while the value of "b" was found from the slope of the line. These values are important for designing and planning a system of refuse management. For example, when the trip number per day for hauling refuse from a refuse generation place to a designed location of a disposal site or a transfer station, those constants and figures are needed. However, for the case of Klang Valley, other figures of unit operation, such as exact figure of operational cost per unit of volume or weight; or distance should also be studied in order to find a comprehensive planning and design of the refuse collection system.

Table 4 : Refuse Collection Facilities Used in Klang Valley

Facility	Kuala Lumpur	Gombak	Petaling Jaya	Shah Alam
Manual loading compactor	60	8	9	8
Mechanical loading compactor	87			
Open loading	74	28	-	-
Roll-on Roll-off	8	-	2	1

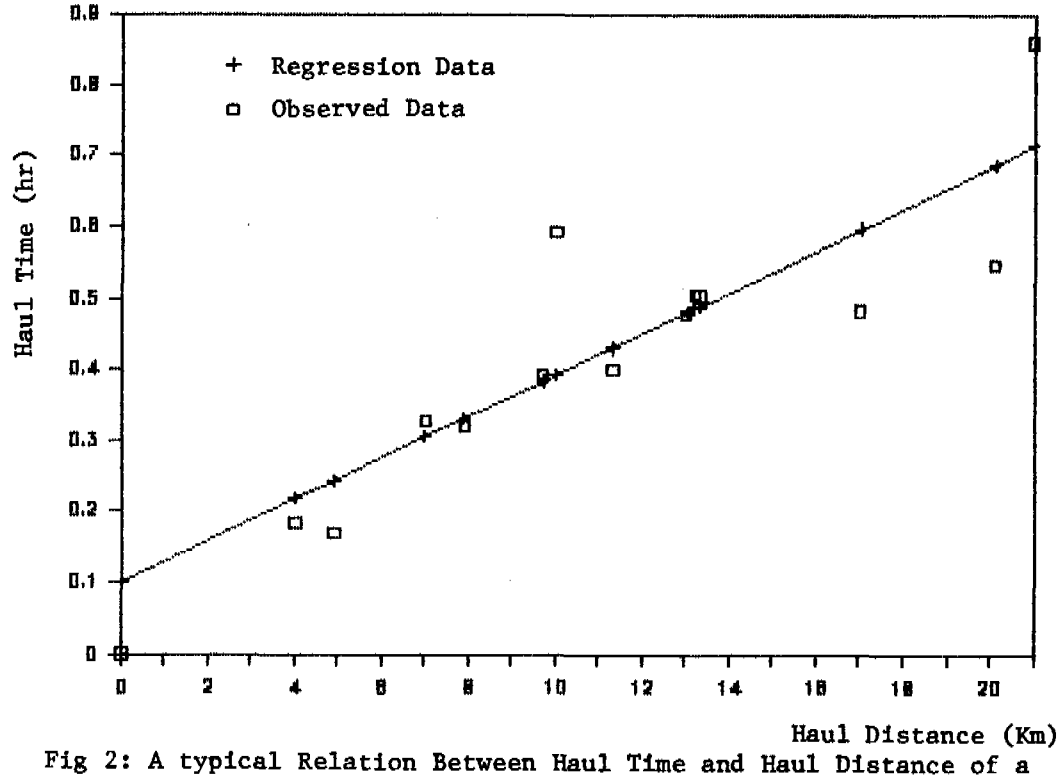

Fig 2: A typical Relation Between Haul Time and Haul Distance of a Loaded Collection Vehicle.

Table 5: The Result of The Refuse Collection System Analyzed in Klang Valley

Unit Operation	Kuala Lumpur scs	Kuala Lumpur hcs	Gombak District scs	Gombak District hcs	Petaling Jaya Municipility scs	Petaling Jaya Municipility hsc
Date	Sept-Dec 86		Feb-Jul 87		Sept-Dec 87	
Collect time (h/trip)	4.7	1.342	2.38		2.37	3.6h/d
a (h/trip)	0.107	0.059	0.085		0.102	0.145
b (h/Km)	0.019	0.016	0.027		0.029	0.024
Pickup time (h/trip)	2.67	0.35	1.39		1.79	0.08
Haul time (h/trip)	0.402	0.323	0.477		0.47	0.58
Haul dist. (km/trip)	4.10	2.7	14.92		11.72	18.7
At-site time (h/trip)	0.12	0.094	0.05		0.16	0.11
Off-route	0.28	0.43	0.273		0.383	0.49

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SESSION 1V
COMMUNITY, SANITATION AND WATER SUPPLY

Chairman: Dr Morag Bell
Department of Geography
Loughborough University of
Technology

PAPERS PRESENTED

GEOFFREY A PIGGOTT
Sewering two Asian cities

MANUS COFFFEY
Low cost latrine emptying vehicle

FADIL HAJI OTHMAN
Klang valley refuse collection analysis

DISCUSSION

GEOFFREY A PIGGOTT

1. Mr GHOSH asked what was the sewerage problem in the peri-urban and rural hinterland area of Shanghai in the same catchment and how was it handled.

2. Mr PIGGOTT replied that the major pollutant sources in Shanghai were industrial and not domestic. Domestic wastes generated in the city were handled relatively efficiently and most nightsoil wastes were used as a soil conditioner/fertilizer. As all major industries were located in the city area this was where the major problems lay and these were being tackled first. There appeared to be a reduction in the agricultural demand for nightsoil and the domestic wastes generated in the city would eventually be discharged to the new sewerage system. In the peri-urban and rural areas the author predicted that the nightsoil would continue to be used for agricultural purposes for many years to come, but in the end it may be necessary to consider other forms of sanitation.

3. Mr KAMANIDDIN CHE LAH commented that sludge was a major problem in many developing countries, especially where the trenching method was not adequate. He asked if any of the speakers had any experience of low-cost sludge disposal.

4. Mr PIGGOTT expressed his belief that treatment and disposal should go hand-in-hand. The one could not be separated from the other. Where sludge was to be used for agricultural purposes etc, treatment (anaerobic digestion plus lagooning) was essential. Sludge disposal was usually either capital intensive or labour intensive. In countries where labour costs were low and where the climate was suitable, the use of drying beds for the further treatment and dewatering of digested sludge was a good option, particularly if the dried sludge could be used as a fertilizer. Where large volumes of sludge were generated at large municipal sewage works, disposal was a real problem. Dewatering was essential if, for example, the sludge was to be carted to a landfill site for disposal. The author thought there was no solution to the problem. Each case would have its own solution.

5. Mr KAMNIDDIN CHE LAH wished to know if Brunei and Shanghai were going to charge connection fees and user fees and if so how much.

6. Mr PIGGOTT replied that in the future both Brunei and Shanghai would charge connection fees. Brunei already charged user fees to cover maintenance. As there was little domestic sewage presently being discharged to the existing sewerage network, revenue from domestic users in Shanghai was small. Proposals existed to change user fees for the proposed sewerage project. Domestic charges would be added to existing water billing procedures whilst industry would pay on the basis of flow and concentration. These charges were likely to be commenced, within the next year or two, over the whole city, not just the Stage 1 sewer area construction which would not be completed until 1992/93. The author regretted that he did not have with him the current and proposed changes for Shanghai and Brunei. Affordability studies were carried out as part of the Shanghai project investigation and preliminary design. The proposed charging rates would be affordable to the community and to industry.

7. Mr KAMNIDDIN CHE LAH asked how people in Brunei and Shanghai would be forced to connect to the trunk sewer.

8. Mr PIGGOTT said that Brunei had had difficulties in the past in encouraging people to connect to the sewerage system. It had only been in recent years that the last of the nightsoil systems in Bander Seri Begawan had been replaced. The Government of Brunei currently had no legislation enabling it to force people to connect and the politicians and administrators were reluctant to put pressure under people. Brunei recognised this as a problem area and it was likely that new legislation and procedures would be implemented to assist in this regard. Perhaps another way of encouragement might be to set a higher user fee when the sewer was available to a property and that property was not connected. In Shanghai a new self-funding autonomous Sewerage Authority would be established as part of the

new project. New legislation and procedures would be initiated which would, hopefully, avoid the problems of non-connection. Another approach which was probably worth considering was connections as part of an overall project of sewerage reticulation, pumping stations and treatment and to construct them as part of the project. This approach had been adopted for recent projects in Brunei. Obviously the cost of the connections, and how this fitted in with the overall funding proposals, needed to be considered.

9. Mr KOLSKY asked if there were regions (eg unplanned, peri-urban areas, uneven terrain, narrow streets) where sewerage was inappropriate and if so what were the sanitation proposals for these areas.

10. Mr PIGGOTT explained that a major component of the project design for Shanghai had been in identifying suitable routes for link sewers and major structures. In a city as congested as Shanghai this had been a huge problem and in some areas it was proposed to actually demolish rows of housing to be able to construct sewers and pumping stations. Much of this housing was of a very poor standard and the opportunity was being taken to upgrade it at the same time. This also involved temporary housing whilst construction was in progress.

11. Mr KOLSKY commented that Mr PIGGOTT's paper discussed the issues of environmental quality in terms of DO. He wished to know if there were public health issues involved. If so what were they, how were they addressed and what was the outfall configuration.

12. Mr PIGGOTT said that DO was used as a convenient method of establishing overall loadings on the Huangpu River and its distributaries. The water quality regulations also had specific requirements in terms of metals, pesticides etc, as well as bacteriological standards. Improvements in public health were a major aim of the project but were difficult to quantify. Shanghai's water supply was drawn from the same river system. Water supply intakes had recently been relocated upstream of the city to try to improve drinking water quality. High phenol and metal levels had been a problem in the past. Improvements in the water supply had been coordinated with the sewerage project. The outfall system would consist of twin 3.5 m diameter tunnels each approximately 1.3 km discharging at an average water depth of 13 m. At the downstream end of each tunnel would be a 400 m long diffuser incorporating vertical risers up to the estuary bed. Current velocities in the estuary averaged about 1 m/s and rapid mixing would occur over the full water column. Under the worst conditions of drought estuary flow and peak ourfall discharge the minimum dilution achieved at a radius of about 1 km from the outfall would be 100:1. This would reduce effluent concentrations to background levels or below.

13. Mr KOO HOCK SONG asked how it was proposed to provide sewer facilities to Kampong Ayer.

14. Mr PIGGOTT explained that studies had been carried out to examine possible alternatives for human and solid waste disposal for Kampong Ayer. Consultants had made proposals to provide a sewerage system using a combination of conventional and vacuum sewers. It was proposed that these sewers should drain to sewage treatment plants located onshore. The Brunei Government was currently considering these proposals but it was likely that sewerage would only be provided as part of an overall housing/infrastructure upgrading some time in the future.

MANUS COFFEY

1. Mr GHOSH wished to know how Mr Coffey's firm transferred the technology, selected industrialists and manufacturers and maintained the quality. He also wished to know if it was a commercial venture.

2. Mr COFFEY explained that the intention was to promote local manufacturers wherever it was economically feasible. Manus Coffey Associates Limited were consultants and could provide all the design and production engineering back-up required. This could often involve some re-design to suit locally manufactured components such as engines etc. The complete vehicle could also be provided by a manufacturer in Ireland and this company could also assist with training local personnel. Any "bought-in" components which could not be manufactured locally could be supplied in kit form.

3. Mr LANE asked if it was practicable to add water to slurry high density latrine wastes in order to make them more pumpable.

4. Mr COFFEY said that due to the high density of the wastes it was difficult to get the water to mix with the wastes at the bottom of the pits where they are the most dense and difficult to pump. He was hoping to experiment with some form of mechanical agitator, possibly using a modified post hole auger to mix the wastes with added water.

5. Mr LANE also wished to know if, in introducing new technology however apparently superior, Mr Coffey encountered marketing problems in overcoming the innate conservatism of the client organizations.

6. Mr COFFEY explained that he was working with UNCHS on a report aimed at helping the decision makers to assess the cost/benefit analysis of different systems to enable them to arrive at an informed choice of equipment. This would be followed with a simple computer programme and an algorithm to direct the end users into asking the questions which would lead to a proper analysis of their needs. There were very serious problems with high pressure salesmen convincing uninformed purchasers to buy totally inappropriate vehicles.

14th WEDC Conference

Water and urban services in Asia and the Pacific

Kuala Lumpur 1988

Disposal and utilization of steel plant waste

Dr N K Upadhyay and Ms P Upadhyay

INTRODUCTION

The industrial city of Jamshedpur, with the pioneer steel plant of India, is situated at 86.2 Longitude and 22.8 N Latitude, 600 ft above sea level in the state of Bihar. It is 250 Km west of Calcutta. In the process of industrialisation since 1904, Jamshedpur and its surrounding have developed into a conglomeration of about 500 industries of heavy, medium and small scale. The population as per 1981 census is 670,000. The city planners were and are visionary in solving many problems of disposing and utilizing the municipal and industrial waste.

In this paper we want to project the commendable work done by the Tata Iron Steel Co. in managing the township. The waste disposal and civic facilities are interrelated. The waste of Jamshedpur can be classified into municipal waste and industrial waste.

The municipal waste of sewage type have been taken care by the sewage treatment systems and the treated effluents are discharged into the river systems. It is one of the township in India which cared for sewage treatment since 1930. It also has developed the system of community latrines for the poor sections of the city dwellers. In last ten years it also has developed a system of "Sulabh Sauchalaya" by constructing public toilets at important locations, these toilets are self governed.

The main problem of Jamshedpur is to manage and maintain the solid industrial waste. The principal solid waste generating industry is the Steel plant and particularly its blast furnace and thermal power generating system.

The solid waste generated by the industries can be categorised as follows :-

1)	Blast Furnace	2,000,000 ton p.a.
2)	Thermal Power Plant	4,38,000 p.a.
3)	Other Industries	50,000 ton p.a.

The systematic disposal of the waste is the problem of the industries as well as the civic authorities. To meet this problem and to avoid solid waste or soil pollution, the management has met the problem on following grounds :-

A) Recovery of valuable from the waste.

B) Disposal and utilisation of waste in urban planning.

C) Disposal of waste towards better environment and ecological balance.

(A) RECOVERY OF THE VALUABLE FROM THE WASTE :

1) From slag-the waste generated from the plants at first are sorted out and the metallic waste of larger size, such as pig iron jam, iron cutting etc. are recovered by its method. A contractor company used to do this job and now the job is done by a nationalised company "The Ferro Scrap Nigam". This company has a turnover of more than Rs.10,000,000 p.a. (Rs. 23 = 1£).

The blast furnace waste of granular nature recovered from slag are used in cement industries and about 500,000 ton of slag is taken by the cement manufacturing industries at a nominal cost of Rs. 50 per ton.

The remelting solid waste are dumped at various places as desired by town planners. This supposedly useless waste when comes out of the industries and dumped, becomes the source of earning for the poor. The poor people further recover the materials of use from the thrown waste. Since 1980, they are working on an organised manner by forming a "Slag Pickers Co-operative Society". The Society is collecting the entire recovery and selling it to consumers. In 1986-87 the society had 1080 members or dependent families. The total turnover was around Rs.78,00,000. The items recovered are as follows :-

TABLE - I

Item	Sale rate per Ton in Rs.
1. CAST IRON	
a) Above 5 Kg.	1700.00
b) Below 5 Kg.	1300.00
c) Chips	700.00
d) Hard Casting	700.00
e) Rounds	300.00
f) Scales	300.00
g) Rejected	800.00
2. MILD STEEL	
a) Jam Big	600.00
b) Jam below 1 Kg.	300.00
3. FERRO MANGANESE	5500.00
4. FERRO SILICON	11000.00
5. MAGNESITE BRICKS	1500.00
6. CHROME MAGNESITE BRICKS	400.00
7. FIRE BRICKS	400.00
8. MILD STEEL ROLLING	2300.00
9. MILD STEEL MELTING	1500.00
10.NON FERROUS (NON COPPER)	1500.00
11.NON FERROUS COPPER BEARING	5500.00

TOTAL TONNAGE OF ABOVE ITEM RECOVERED IN 1986-87 ABOUT 4500 TONS.

2) Disposal of Fly Ash & Coal :

The another major waste is fly ash generated from the Thermal Power Plants. The generation of this ash is around 438,000 tons p.a. about three or fourth of it is given into river system as the slury. The composition of the ash is as follows :

TABLE - II

FLY ASH COMPOSITION IN PERCENT

SiO	-	50.08
Al_2O_3	-	23.52
C	-	11.20
FeO	-	1.55
Fe_2O_3	-	6.15
CaO	-	2.00
MgO	-	.72
MnO	-	traces
P_2O_5	-	1.5

The remaining fly ash is used in dumping as per the town planners desire.

The other waste is the ash and coal from the various furnaces of industries. There is further recovery from this waste. The coal is further recovered from this at an average of 7000 tonnes p.a. or about Rs.2,000,000 p.a. This coal is again used in catering the need of the house holds of the city. About 500 families are engaged in this work.

3) Other Waste Materials :

The other waste which includes degradable and non-degradable type are dumped at various sites as desired by the planners in the systematic manner.

(B) DISPOSAL AND UTILIZATION OF WASTE IN URBAN PLANNING :

The solid waste is dumped after careful planning and selection of site. It has helped in the levelling of low land, in constructing the embankments for flood control, in constructing roads etc. By this planning the many areas have been developed for the housing and recreational purposes.

All along the river line of the Jamshedpur city, the industrial solid waste have been dumped in such a way that they have elevated the river banks and have been working as an embankment to keep away the flood water from the municipal limits of the city. It is also preventing the soil erosion.

(C) DISPOSAL FOR BETTER ENVIRONMENT AND ECOLOGICAL BALANCE :

Due to rapid expansion of industries in the post independence era after 1974, Jamshedpur was heading towards a polluted city, but due to planning the rate has been checked.

There is awareness in this direction and so each year, massive aforestation programme is being carried out. In the year 1986-87 10 million trees were planted in the city of Jamshedpur, the after care was also been done by the Notified Area Committee and Park & Garden Dept. of the company. The overall survival rate of the planted saplings are 50-55%, in some areas it is 90-100%. There is a proposal to make and develop Jamshedpur as the greenest city in this part of India.

There is also a plan to develop the top soil on the dumped areas for natural growth of grasses and to check soil erosion. This will lead to the succession of plant communities, which, in course of time

can be developed into recreational parks or housing site.

However, the solid waste can be utilised still, on a better way and more valuable materials can be recovered, particularly P_2O_5 content of the slag and fly ash can be used as fertiliser. The high content of silica and aluminium in fly ash can be used in manufacturing of bricks. The Al_2O_3 content of the fly ash can further be utilised for the manufacture of aluminium based chemicals such as alum or aluminium hydroxide. No worker or enterpreneure has come forward as yet to work in this direction. At least 100,000 tons of Al_2O_3 is unutilised and is going for dumping, or going in river system or in making air polluted by the particles. Therefore there is a further scope to work in this direction.

SUMMARY :

Jamshedpur, has shown that by proper management, the industrial and urban planners can generate wealth from the waste. From various estimates it has been revealed that at present atleast Rs 20.00 per ton materials are recovered, leaving aside the benefit this solid waste management is giving in town planning, environmental management and ecologicl balance of the city. This example has given an idea for other steel plants also towards the solid waste management in India. But the Jamshedpur experience is the first mile stone in this direction.

ACKNOWLEDGEMENT :

The authors gratefully acknowledge the help given by the Management of Jamshedpur Notified Area Committee, Tata Iron & Steel Co. Ltd., & Slag Pickers Co-operative Society in giving the data for this presentation.

The authors are also thankful to all institutions which have made it possible to present this paper at the conference at Kualalumpur. The authors are grateful to the organisers of the conference and WEDC Management for giving the opportunity for presenting the Jamshedpur experience at the international conference.

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Water and urban services in Asia and the Pacific

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Disposal of excreta and sullage

C Kariyawasam

INTRODUCTION

Both safe water supply and sanitation are equally important in achieving health goals in communities(ref.2). However water supply projects has been able to attract the attention of the beneficiaries more than the sanitation projects. Major reason for this is the resulting convenience to beneficiaries from water supply projects. Despite this preference for water supply projects the governments and donor agencies have managed to focus the attention of people on sanitation projects, because of

a) health hazards associated with exposed night soil

b) desire of the society for a cleaner and aesthetic system which is a result of rising living standards and education

c) peoples demand for doing away with the practice of human beings carrying night soil loads(ref. 3)

As the end users the people do always participate in sanitation projects. Peoples participation also can be obtained at the planning, design and implementation levels of a project. Even though this has become a popular theme among donor agencies active peoples participation at all these levels is obtained very rarely in sanitation projects. Major reason for this is the failure to understand the behaviour of the people(ref 1). To understand and predict the behaviour of people one must be aware of the knowledge, attitude, and practices of the beneficiaries. This paper presents the results of a survey carried out on the knowledge, attitude and practices of five different communities in Sri Lanka on the disposal of sullage and excreta.

DESCRIPTION OF THE SELECTED COMMUNITIES

The following five communities were selected for the study.

a) a settlement scheme
b) an urban area
c) a traditional old village
d) a fishing village
e) an urban slum area

Galoya, the selected settlement scheme is located near the East coast of Sri Lanka. This is the largest single irrigation scheme in the country which was completed in 1950. Total irrigated area under this project is about 40,000 hectares. Majority of the farmers grow paddy. About 4000 hectares of sugar cane is also grown by a public agency. Originally farmers were allocated lots varying from one to ten hectares depending on their capability manage.

Panadura, the selected urban area is located about 27 km. South of Colombo, the capital city. This is a fast developing satellite town with all basic facilities. The soil in this area is sandy, and the groundwater table is relatively high.

Bandaragama, the traditional old village selected is located about 40 km. South-East of Colombo. The soil type in the area is sandy clay with several rock outcrops. The average elevation is about 15 meters above mean sea level.

The fishing village selected is located inside the city limits of Wadduwa, a town 35 km. South of Colombo. The rail track connecting Colombo and Galle, the capital of southern province, runs through this village. Being located near the beach the soil is sandy making it difficult to dig pits.

The urban slum area surveyed is located in Maradana, a suburb of the Colombo city. This is a squatter settlement that grew up during 1940's on previously unutilized land that belonged to the government. The soil in this area is sandy. The average elevation above mean sea level is about a meter.

SOCIO ECONOMIC CONDITION OF THE STUDY AREA

Majority of the people in the Galoya settlement scheme are paddy farmers. They grow paddy twice an year. As a result they receive their annual income in two instalments. These farmers have come from different parts of the country. As such they belong to different cultures, religions and castes. As part of the irrigation project the government has constructed semi permanent houses for the farmers. However with the addition of second and third generation farmers new houses had been constructed. As a result there are several temporary houses within the scheme. The average annual income of a farm family is about Rs. 18,000. At present (January 1988) one US dollar is about Rs. 30.

People in the Panadura area are monthly wage earners who work for the government or private firms in the city of Colombo. As such they leave their homes in the morning and come back late in the evening. There are few businessmen. In most families both husband and wife are employed. Majority of the people in the area have permanent houses. Most of the houses have three bed rooms a living room and a kitchen. The monthly wage earners generally obtain a long term loan on reduced interest rates from the government to construct a house. The average annual income of a family is Rs. 46,000.

Majority of the people in Bandaragama are part time farmers. They grow cash crops. There are few government servants who work in the nearby offices. Generally all families receive a regular income. In this community the houses are fairly old. Most of them constructed over 50 years ago. These houses generally consist of a large varendah, a living room, a large store room, a kitchen and about two bed rooms. The average annual income of a family is Rs. 25,000.

All the people in the fishing village are fisherman who work daily for a period of about 9 months. During the three months when the seas are rough they used to migrate to the east coast for fishing. However after the ethnic problems that cropped up in 1983 these fisherman do not migrate. As such they are not employed for about three months of the year. As expected various types of social and economic problems crop up in this community during these three months. All the 65 houses in this community are temporary ones. Both roof and walls are made of cadjan. Generally they have one living room and a kitchen. Kitchen is used only on rainy days. On other days cooking is done outside. The average annual income of a family is about Rs. 11,000. As indicated earlier they receive this income over a period of 9 months.

People in the urban slum area are those who migrated from south where the unemployment rate is high. This community provides cheap labour for the Colombo city. All the houses in the area are temporary ones. There no water service or electricity connection to the houses. The houses do not have clearly marked access paths. There are no boundaries. About 90 houses are clustered within an area of about 0.5 hectare. There are about 900 people living in this area. In certain houses only half of the family can sleep inside at a time. As such half the family sleep till midnight while the other half loiter in the street. At midnight they swap. There is no source of regular income for these people. Most of them work as casual labourers. The only people who receive a fairly steady income are the astrologers, cobblers, and the street vendors. The income of the community drops drastically on rainy days. The average annual income of a family is Rs. 10,000.

Table 1 summarises the basic socio economic characteristics of the five different communities.

Table 1: Socio economic characteristics of the selected communities

Community	Population	Area in Ha	Population Density in persons/Ha	No of people per house	Average annual income in Rs.	Annual per Capita Income (Rs)	Value of land in Rs/Ha
a)	70,000	1200		6.2	18,000	2903	100
b)	5,000	300		4.8	46,000	9583	2400
c)	2,200	500		5.3	25,000	4716	1300
d)	1,100	9		8.1	11,000	1358	4500
e)	950	0.5		12.8	10,000	781	20,000

Note: The area allocated for farming activities was not considered in computing the population density

KNOWLEDGE OF THE PEOPLE

Majority of the people interviewed, including the ones who had a formal education did not consider that there is a health hazard in improper disposal of excreta. Only 11, 16, 5, 2, and 2 percent of the people respectively, in each community considered that proper disposal of excreta is required for health reasons. About 32 percent of the people of all communities were of the opinion that proper disposal of excreta is required for aesthetic reasons and to avoid social embarrassment.

As expected low income group people of all communities were less knowledgeable about sanitation in general. However, some educated people felt that the governments exaggerate the hazards associated with the improper handling of excreta and sullage. They argued that excreta is a natural product that is as old as the human race, and before the introduction of latrines people have been defecating in open areas without major problems.

Poor knowledge is a result of low literacy rate in low income groups. Even large colour posters specially designed for illiterate people were understood only by the literate people. The reason for this is that the people who are illiterate are also generally visually illiterate.

ATTITUDE OF THE PEOPLE

People in the urban area generally considered having an expensive western type bathroom as a symbol of progress. About eighty percent of the people who had western type of bathrooms did not use them. They had a separate inexpensive toilet and bathing facilities for their use. The western type bathroom was reserved for the guests and visitors. There was one house with two expensive bathrooms, but they had a separate toilet outside for their use.

Farmers in the settlement scheme considered having their own toilet as a status symbol. In this community the second and third generation farmers shared the toilets with the original settlers. The attitude of the people in the old village on the disposal of excreta and sullage was similar to that of the irrigation settlement. They had their own toilets, generally about 20 yards away from the house.

There was not a single toilet in the fishing village or in the urban slum area. These people did not place a high priority for constructing toilets. In the fishing village the major reason was the non availability of funds. In the slum area the constraint was the land. The value of land in this area was very high. As such they could use the land for other 'profitable' purposes than constructing toilets.

During the survey they were asked what they would like to do if they receive Rs. 10,000. They were given five options. Construct a toilet, buy a colour television, buy a refrigerator, buy a motor cycle, or go abroad for each employment. Each activity requires about Rs. 10,000. They were also asked to assume that they do not have any of the above items. Results of this part of the survey are presented in Table 2.

Table 2: Priorities of people in different communities expressed as a percentage

Community	Toilet	TV	Refr.	Mo.Cyc	Employment
a)	60	12	8	15	5
b)	95	3	2	0	0
c)	65	13	12	10	0
d)	3	35	12	30	20
e)	0	60	0	5	35

It can be seen that people in the urban slum area and in the fishing village considered having a colour television more important than having a toilet.

PRACTICES OF THE PEOPLE

People in the old village were the ones who were very much concerned about proper disposal of excreta. They cleaned their bodies with soap and water after using the toilets. Since this village is located within the wet zone of the country there is no shortage of water in this village. Each person used about 10 litres of water for this purpose. People in the settlement scheme used the toilets when they are at home. Being located in the dry zone of the country there is a shortage of water in this area. as such people use very much less water for cleaning after defecating. The average consumption is about 2 litres. There were some people who used about half a litre. The adults generally spend most of their time in the paddy fields. As such during day time they use a drainage ditch or a jungle for defecating.

Children in the age group 4 to 12 use to go to an irrigation canal bank, jungle, or an unoccupied land for defecating. The adults discouraged the children from using the latrines for safety reasons. However the risk of children using the toilets designed for adults depends on the type of toilets. Table

3 summarises the different types of toilets that were available in the communities studied.

Table 3: Types of toilet systems used by people in different communities expressed as a percentage

Community	CFWC	CFSP	PFSP	VL	NVL
a)	4	12	68	5	11
b)	44	15	21	20	0
c)	2	13	71	14	0

Notation:
CFWC - Cistern flush water closet
CFSP - Cistern flush squat plate
PFSP - Pour flush squat plate
VL - Ventilated latrine
NVL - Non ventilated latrine

The rubbish collected were burnt or deposited in a pit dug for this purpose. There seems to be no major problem with sullage in the old village or in the settlement.

In the fishing village people go to the beach or the rail track to defecate. At the beach they hand dig a pit of about 30 cm. deep for this purpose. After using they cover the pit. The sullage is thrown to the sea or to the rail track.

In the slum area people go to the open storm sewer to defecate. At night they go to the road side. Women use a public latrine which is located about a kilometre away.

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14th WEDC Conference

Water and urban services in Asia and the Pacific

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Polypropylene reinforced cement sheets

Dr Mohd Warid Hussin
and Kamsiah Bte Mohd Ismail

SYNOPSIS

The paper examines the effects of the addition of polypropylene mesh of different types and volumes upon the flexural load - deflection properties of a cement matrix at different ages developed at Universiti Teknologi Malaysia Laboratory. The products were chosen to highlight its potential use in low income housing and are intended to be used as an alternative to asbestos cement sheets. The major application of the composite will be as corrugated sheeting for roofing and cladding. The sheets consist of 1% to 10% by volume of polypropylene mesh in cement matrix. Comparative tests are also reported with the flexural behaviour of asbestos cement sheets. Both sheets underwent 4 - point loading and the results indicated that the new sheeting can satisfactorily sustain the loads showed by corrugated asbestos sheets.

INTRODUCTION

The interest in utilising the cheapest material for making low cost construction materials has been growing in recent years. Although the cost of cement is considered low, it cannot alone be used as a material for construction because it cracks easily and fails in a brittle mode. The inclusion of fibres to cement has solved the problem especially when the inclusion of asbestos fibres in it was discovered. The result was the large scale production for flat and corrugated asbestos cement sheet especially in the late nineteenth century. But, due to health hazards ascribed to asbestos fibres, there is a strong tendency to replace them with other fibres. There is also a strong indication that the supply of cheap asbestos fibres may be exhausted in the future (1). According to Baroonian et.al, relatively very few information has been published about the performance of asbestos cement under the recommended design loads (2). Therefore, an economic and safest material construction is sought to develop the non-asbestos cement based composites.

Polyolefins such as polypropylene fibres can be an economic and safest alternative to asbestos fibres. The fibres are cheap and can withstand attack by strong acids and alkalis as such make them more durable than other fibres. The fibres have been used for many years despite of their low modulus of elasticity. For instance, the successful use of polypropylene fibres in the manufacture of concrete piles to withstand impact loads (3).

Several investigations have already been carried out on various mechanical and physical performance using polypropylene fibres (4-9). These investigations have shown encouraging results.

The objective of this study deals with the reinforcement of corrugated sheets using two different grades of polypropylene woven mesh. Their benefit in increasing the flexural load deflection is experimentally evaluated under the variation of fibre types and sizes, different volume fraction of fibres (V_{RL}) and different ages of the specimen. The results are compared with typical commercially available corrugated asbestos cement sheet cut to required length.

TEST PROGRAMME AND METHOD

The asbestos cement corrugated sheet tested was a typical commercially available sheet of overall depth 57 mm, cross-sectional thickness 6-9 mm and pitch of corrugations of 45 mm.
Polypropylene reinforced cement (PRC) sheets were manufactured by hand in the laboratory. The matrix was cement paste with 0.45 water/cement ratio and constant for all the mixes. The properties and fibre structure of polypropylene woven mesh used in the investigation are given in Table 1.0 and Figure 1.0.

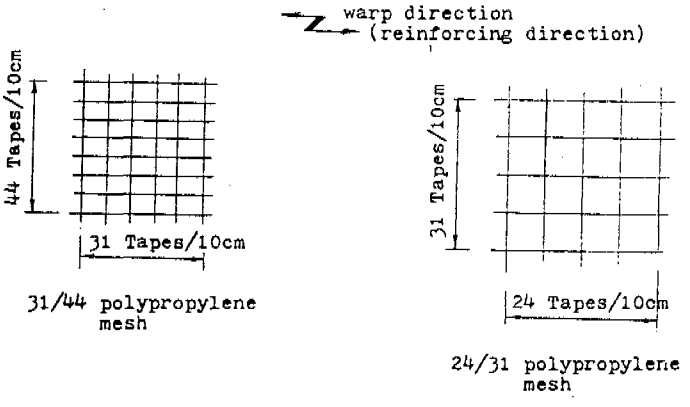

Figure 1.0 Types of polypropylene mesh used in the investigation

Table 1.0 Properties of polypropylene mesh

Mesh Type	Measured * Thickness (mm)		Measured * Width (mm)		Weft (transverse fibre spacing(mm)	Extension at break + (%)	Measured extension at break (%).
	Warp	Weft	Warp	Weft			
24/31	0.139	0.056	1.024	1.131	3.4	15-20	7.7
31/44	0.297	-.091	1.274	0.730	3.3	15-20	5.7

* Minimum of 30 samples.
\+ Specified by the manufacturer.

A cement paste was spread on the base of the mould. A layer of matting was rolled and this process was continued until the thickness required was obtained. The cement paste was left to set for 2-3 hours in the form of a flat sheet. Later, the flat sheet was laid onto a corrugated zinc sheet supported by strips of woods as in Figure 2, and pressed into corrugations and covered with plastic sheet with water ponded on top for 24 hours before the sheet was cured.

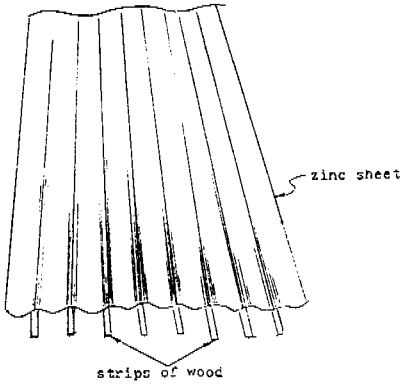

Figure 2.0 Zinc sheet supported by strips of woods.

All samples were 600 x 1000 x 10 mm size with a density of average 2246 kg/m ^{3}. All the sheets were loaded at the third points over a span of 900 mm. Deflections were measured at mid-span under each corrugation by displacement transducer linked to a data logger. Strain gauge readings were similarly monitored at various positions over the sheet.

There are two sets of specimen, one cured in ordinary water for 28 days, and the other exposed to natural weathering for 6 months (180 days) after initial curing in ordinary water for 28 days.

RESULTS AND DISCUSSIONS

The flexural load-deflection curves for PRC and asbestos cement at 28 days strength are shown in Figure 3. It is seen that the curves of PRC are slightly different from that of asbestos cement sheet. The asbestos cement sheet failed at a load of 1600 N at a deflection of 10 mm. Failure was sudden and the sheet broke into two sections as a crack propagated rapidly across the sheet. The ultimate stress was calculated as 29.6 N/mm ^{2}, whereas for PRC, generally all behave elastically until first crack. The load-carrying capacity, however drops immediately after cracking, then increases again with increase in deflection and then gradually decreases until fracture.

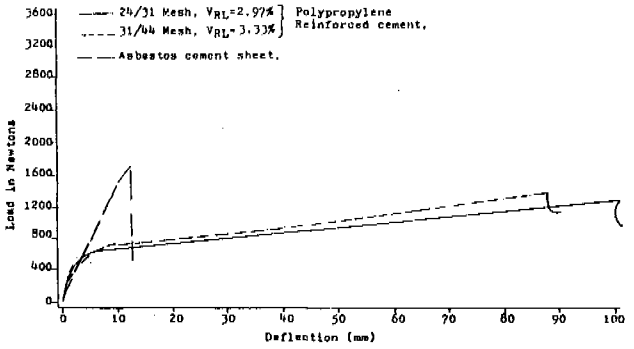

Figure 3.0 Load-deflection curves for corrugated sheets at 28 days strength.

The load deflection curves for PRC comprise two portions. The elastic portion and the inelastic portion. The elastic portion which is elastic before first crack, is the range where only cement carries the load. The fibres do not contribute to load capacity. The second portion, the inelastic range until fracture shows extensive cracking after reaching the ultimate loads indicating considerable ductility. In this region, the fibres carry all the loads.

Table 2.0 summarises important values on the flexural strength of PRC. As expected, the performance of 31/44 woven mesh is better than 24/31 woven mesh. This is probably deduced from their relative fibre structure and properties. The effect of V_{RL} of PRC can be seen clearly to show that as V_{RL} is increased, the better is the flexural strength. Similarly as seen in Figure 4, as V_{RL} increases, the slope after first cracking becomes steeper. This increase in slope is attributed to the viscoelastic property of the polypropylene fibres. Asbestos fibres do not show a similar behaviour because of the brittleness of the fibres themselves and the difference in the reinforcing mechanism.

Table 2.0 and Figure 5 show flexural strength of the sheets at two different ages and curing conditions. Some reduction in strength occurs after six months (180 days) exposure to natural weathering probably due

to the embrittlement of the sheets within this period. But the reserve strength occurs is adequate enough for long term applications.

Table 2.0 Results of Flexural Strength

Fibre Type	V_{RL}(%)	Density Kg/m³		Modulus of Elasticity N/mm²		Stress at LOP N/mm²		Ultimate Strength N/mm²	
		28D	180D	28D	180D	28D	180D	28D	180D
31/44	3.33	2395	2099	17.5	22.5	9.3	6.8	19.4	
"	5.0	2309	2127	30.0	22.5	9.3	9.0	27.8	30.0
"	6.66	2285	2040	17.1	30.0	11.9	9.8	33.0	39.0
"	8.33	2310	2189	21.4	24.0	12.8	12.0	45.8	43.5
"	10.0	2260	2135	20.0	22.5	13.5	13.5	54.0	51.0
24/31	1.19	2423	2124	15.0	12.0	7.5	5.3	7.5	9.0
"	1.78	2510	2238	13.3	23.3	8.3	5.9	20.3	12.0
"	2.97	2396	2148	25.0	25.0	9.8	6.0	21.0	19.5
Asbestos.	-	2451	2453	21.5	19.8	29.6	25.9	29.6	25.9

Note: V_{RL} - volume fraction of reinforcement in the longitudinal direction.
28D - 28 Days strength.
180D - 180 Days strength.

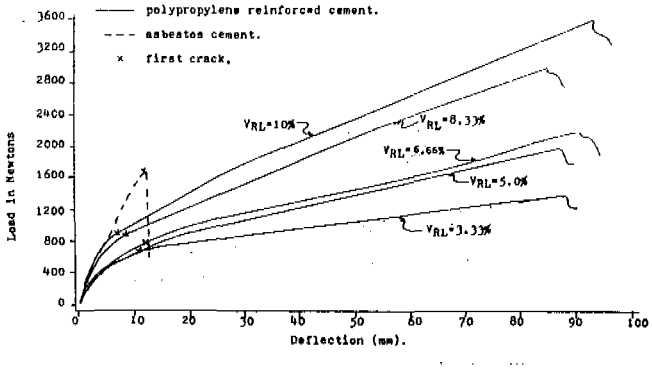

Figure 4.0 Load-deflection curves for various fibre contents for 31/44 woven mesh at 28 days strength and asbestos sheet

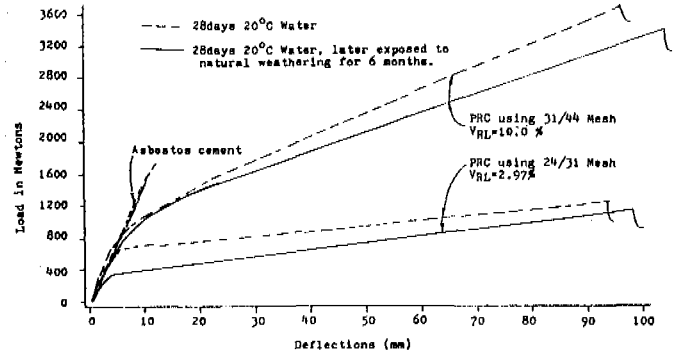

Figure 5.0 Load-deflection curves at different ages

ECONOMICS

Other than cost, which apply to the choice of materials for structural purposes, are the extent of mobility and compactability of the material and hence the ease with which it can be arranged to a required configuration and its behaviour under load.

Often, as in the case of cement, material cost consideration and the ease of application are sufficient to justify the usage of materials. Since PRC represents the whole range of cement, it is not possible to give any cost comparison which is meaningful. The properties of cement, however, permit simplification of moulds and reduction in costs of labour for placing, compaction and finishing, as well as increasing the quality of the end product and reducing the amount of wastage. The finished products of PRC are less likely to be damaged or fractured during handling or placing and when fixed to the building. These factors offer the total cost of a finished item to be minimised, and these savings are more than offset the extra material cost and therefore PRC can be an economical to use.

According to Naaman et. al (10) since the specific gravity of asbestos is three times that of polypropylene, for the same volume fraction of fibres in a given composite, the weight of asbestos fibres would be three times that of polypropylene. As fibre bought in a weight basis, polypropylene may have a substantial cost advantage.

CONCLUSION

The tests indicated that the addition of polypropylene fibre increases the first crack strength with increase in fibre content.

For 5 to 10% of volume fraction for 31/44 woven mesh showed comparable strength to asbestos cement sheet regardless of the types of curing (ages). The addition of 24/31 woven mesh did not increase the flexural strength as the inclusion of these fibres were minimised due to difficulty in casting.

Useful load is sustained after first crack, when deflection increases substantially. Its maximum value increases with increase in fibre content, and this value exceeds the first crack strength. The sheets showed extensive cracking after reaching their ultimate loads indicating considerable ductility. In fact, it is impossible to break the PRC sheets in the test rig as the maximum loads are well above the loads required to be sustained.

The results indicate that very little different in strength changes for both meshes at different ages. But only 31/44 woven mesh can satisfactorily sustain the loads showed in corrugated asbestos cement sheet. The composite retain most of its initial, good mechanical properties when exposed to natural weathering (especially in tropical country like Malaysia) over a period of six months (180 days).

Lastly, the great toughness of PRC is an important asset in its use as a roofing and cladding element and low cost sheeting.

ACKNOWLEDGEMENT

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Technologies for women's low-income housing needs

Dr J C Srivastava

Urbanisation has several components in terms of development viz., increasing trend of existing population growth rates nationwide, influx of rural migrants or from other states in search of employment and transformation of settlements from rural to urban. Due to subcritical and meagre income, such migrants were forced to take shelter with their families in shanty clusters, slum dwellings or squatters settlements.

Ramachandran notes that by the year 2000, almost half the worlds' population will be living in urban areas. This has encouraged identification of cities in developing countries with poverty, inequality, environmental degradation and antisocial behaviour. While large cities in some developing countries have been growing at the rate of 10 per cent per annum, slums and squatter settlements in some of them have been growing twice as quickly (1). In 12 metropolitan cities in India, it has been estimated that 12.25 million people living in slums (1981 census) will swell to about 20 million by 1990(see Table) where proportion of women would touch to about 50-60 per cent (2). Shelter conditions, infrastructure and services are the areas in which most settlements are visibily losing ground. Although urban life offers some good job opportunities and income; for the women of low-income groups, it entailed quite a lot of hardship and drudgery too. These strategies in terms of women's needs must seek to redress imbalances brought about by inputs of science and technology (S&T).

Estimated Urban Population and Slum Population in 1990 in Metropolitan Cities (Persons in lakhs)

Name of the City/Town	Total Pop. 1981	Indentified Slum Population Number	Percent to Col.(3)	Growth Rate 1971-81	Estimated Population 1990	Estimated Slum Population 1990
2	3	4	5	6	7	8
Calcutta	91.94	30.280	32.9	30.35	125.33	43.86
Greater Bombay	82.43	28.314	34.3	37.80	117.89	41.26
Delhi	57.29	18.000	31.4	56.66	97.67	32.08
Madras	42.89	13.630	32.1	34.91	60.22	21.08
Bangalore	29.21	3.050	10.4	76.17	51.86	10.37
Hyderabad	25.45	5.000	19.6	40.74	37.07	11.12
Ahmedabad	25.48	5.363	20.3	43.53	37.76	11.33
Kanpur	16.39	6.140	37.5	32.39	22.84	8.00
Pune	16.86	2.743	16.3	48.48	25.73	5.15
Nagpur	13.02	4.161	31.9	39.50	18.82	5.64
Lucknow	10.07	2.850	28.3	23.66	13.12	3.94
Jaipur	10.15	2.960	29.1	57.78	16.34	4.90
Total:	421.18	122.491	29.1		618.65	198.73

NEEDS OF WOMEN

As women are intimately linked and are more directly affected by housing and settlements environmental conditions, a survey was undertaken to assess their needs, preferences and actual uses. The needs requiring specific attention in terms of dwelling related to (i) space determination and utilization inside the house which may help improve the efficiency in performing the daily domestic chores and reduce drudgery; (ii) provision of a well-laid cooking place with a smokeless and fuel efficient cookstove; (iii) a sanitary latrine which would help in the hygienic disposal of human excreta; (iv) provision of essential services and facilities like waste water disposal, drainage, ventilation and lighting; (v) safe drinking water near the house, and upkeep and maintenance of drinking water resources and water quality improvement; and (vi) methods for prevention of damage to houses and their belonging due to fire and stagnating water during rains and floods.

TECHNOLOGIES

The input/output indicators for application of technologies to meet the above needs were determined as under:

INPUT	OUTPUT
Acceptability, Availability, Affordibility, Maintainability, Replicability	Distinct advantage felt by women for a healthful living and elemination of related hardship and drudgery

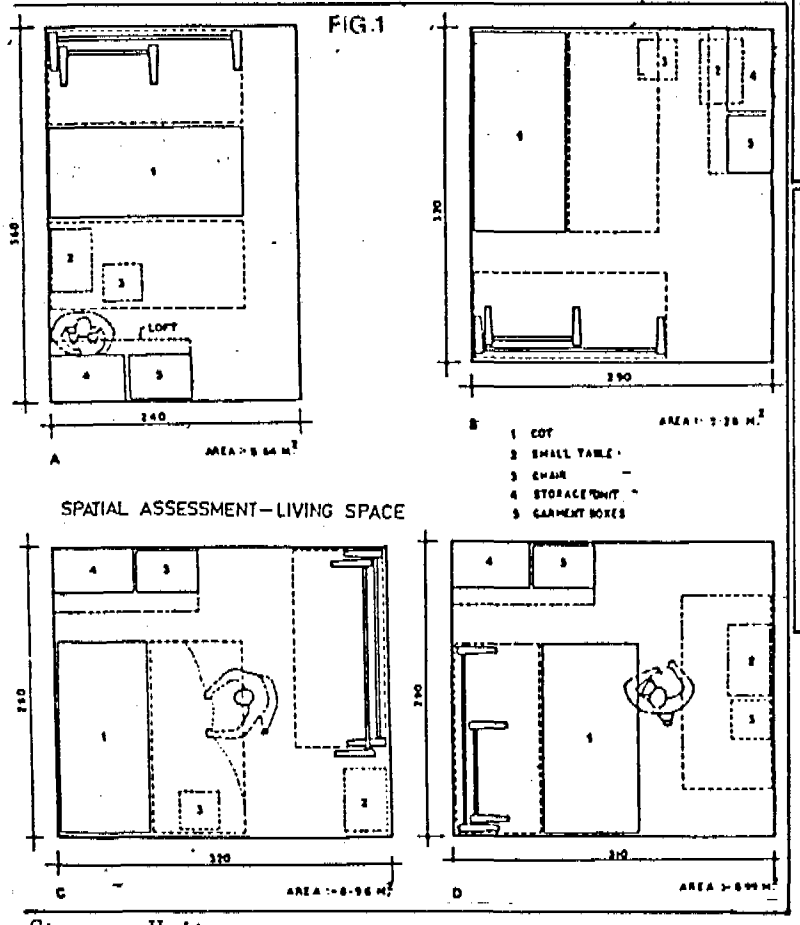
The Central Building Research Institute (CBRI), Structural Engineering Research Centre (SERC), National Environmental Engineering Research Institute (NEERI) and Mechanical Engineering R&D Organisation (MERADO), constituent research laboratories of the Council of Scientific & Industrial Research (CSIR) India have deveoped a number of technologies having scope of adoption by women. The selected technologies which have reasonably met their expectations are briefly presented here.

Space determination

Space determination is related to po sture of working, habits, income levels and capabilities of the women. It is also

influenced by space, structure and design of furniture and fixtures in the house. Minimum floor space for various requirements in a household has been determined as under(3) Living space has been considered to cater needs of sleeping, leisure-time, sitting and storage of household items. Since sleeping during night has been found to be the critical requirement, shifting and rearranging of furniture for day-time and night-time activities were considered. Floor area of these requirements could conveniently be made as 10 m^2 with a minimum width of 2.4m and 2.6m for one and two door arrangements respectively. Figure 1 shows a few such arrangements (minimum floor space for one cot enclosure is 5 m^2 with minimum width of 2.1m).

FIG.1



SPATIAL ASSESSMENT—LIVING SPACE

Storage Unit

A minimum floor space of 0.6m^2 to 0.8m^2 was determined in the living space. A depth of 45 cm and minimum length of 75 cm with provision of shallow shelves of 30cm depth at lower level was worked out for use of children items. Space for storage of cereals, prepared food and milk and fuel storage (in fuel hood) has also been worked out; for which a minimum floor space of 0.21m^2 was worked out (see Fig.2).

Storing, sleeping and day-time working-tops are main activities for which majority of women demanded compact, cost-effective and ready to use type of furniture. A number of designs have been worked out by CBRI to this effect (4) (see Fig.3)

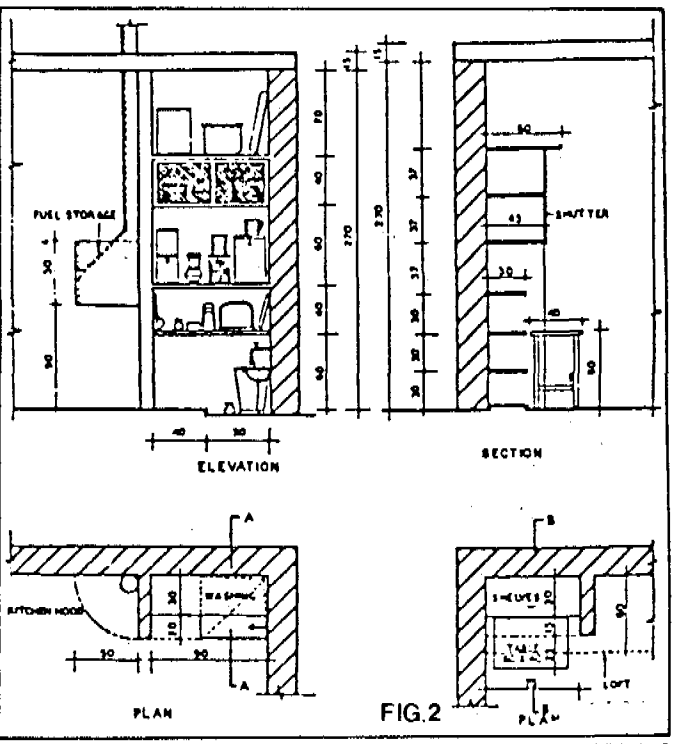


FIG.2

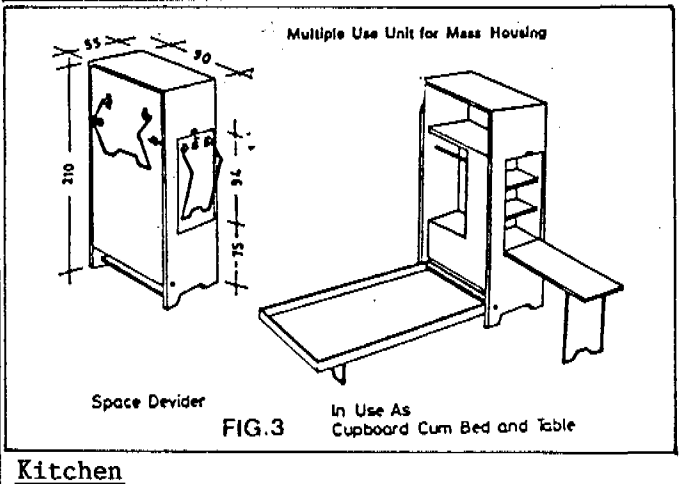


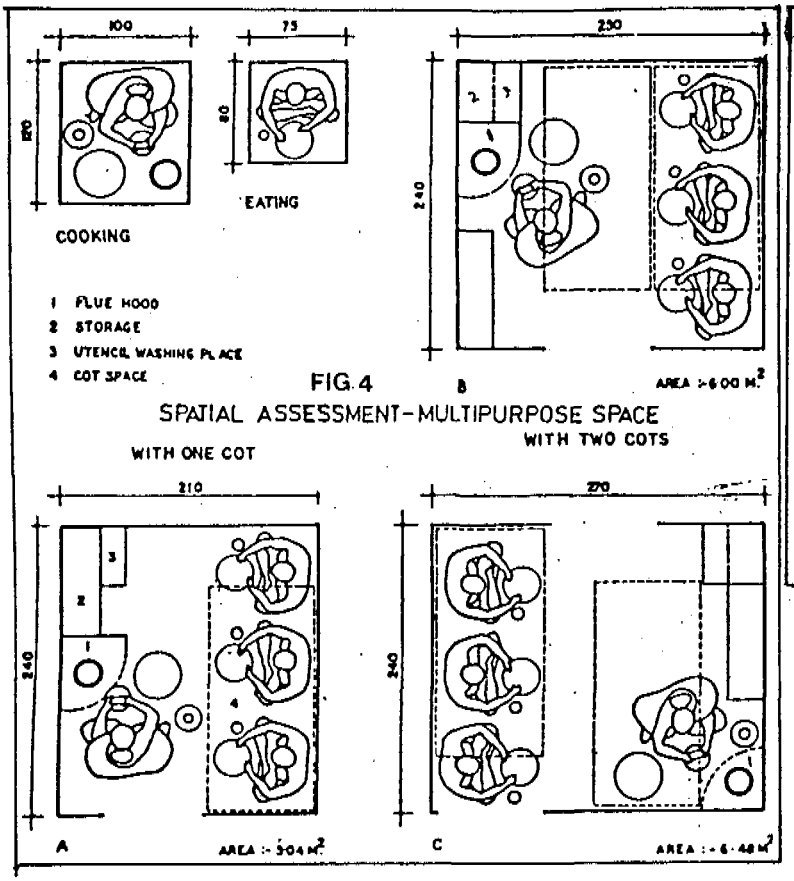
FIG.3

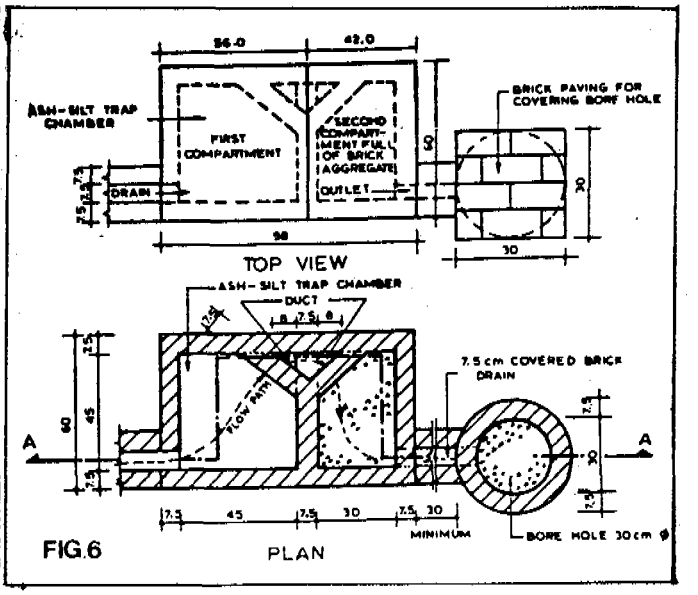
Kitchen

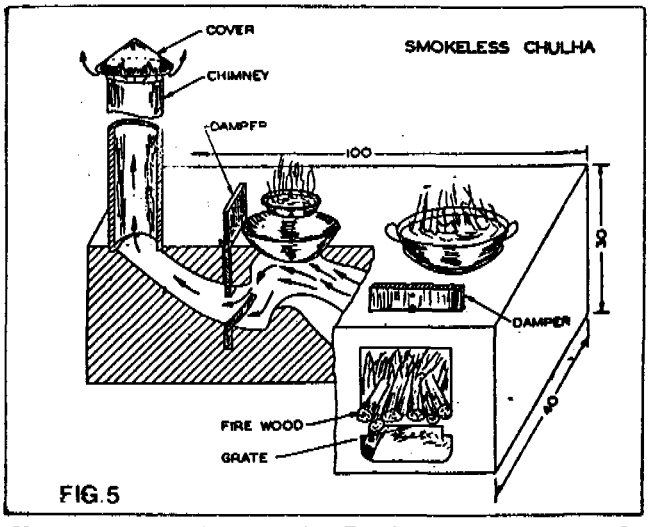
The minimum space requirements for multi-purpose activities related to kitchen were worked out as squatting cooking (120x 100 cm); cleaning of utensils (50x50 cm); storage of kitchen supplies (70x30 cm); eating space for 3 persons at the rate of floor space (80 x 75 cm) per person; and provision of site for cookstove and flue for the exhaust of smoke and fumes. When all the kitchen activities are over, this space shall be used to accommodate cots for sleeping during night at the rate of 5m^2 per cot with a minimum width of 2.1m. A few arrangements of these activities are shown in Fig.4.

Improved cookstove These are equipped with internal damper and chimney to control the fire intensity and to eliminate smoke from the room. The inset pot seal prevents accident al fire that are caused by sparks leaping from scalds (see fig.5).

Energy crisis is also being felt in such settlements. Solar cookers are being promoted with heavy subsidy.



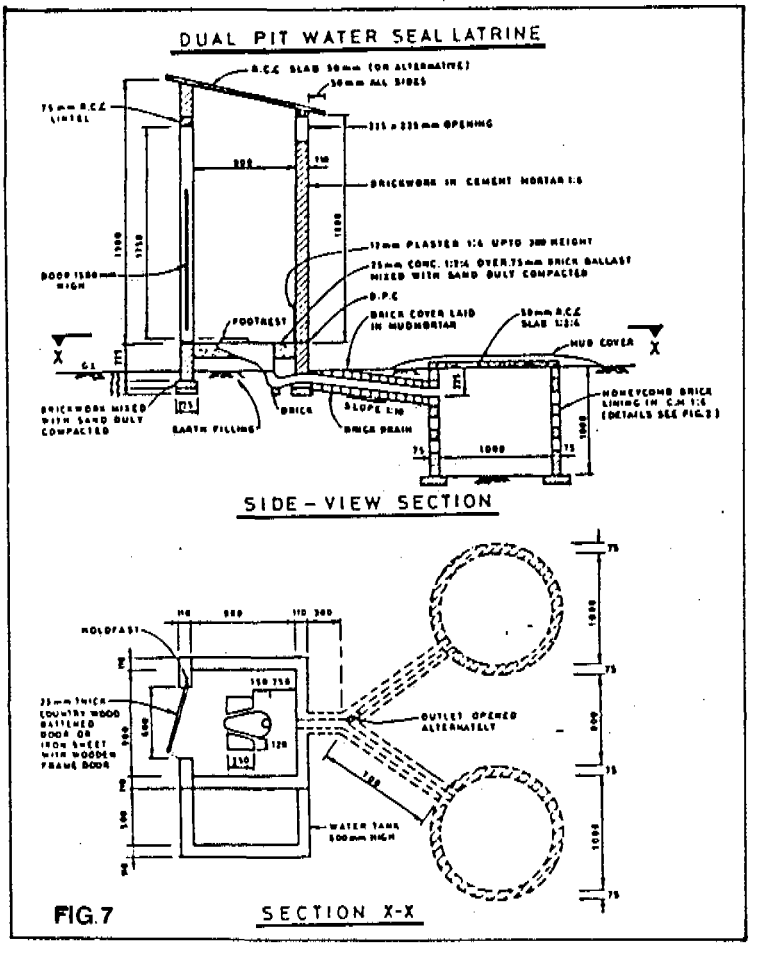




Waste water disposal In low-income settlements, there is practically no drainage. For immediate solution, near the source of waste water disposal, the concept of soakage system has been worked out (see Fig.6). This system consists of two chambers, an ash/silt trap in which silt or ash settles down and the second (filled with brick aggregates) for removal of suspended or colloidal matter in the water. The drain water so filtered flows into a borehole (30 cm depth) for ultimate disposal.

Toilet facilities Minimum floor area for bath and latrine was worked out as 1.4m^2 with a minimum size of 1.1 m for bath and 1.0 m^2 with a minimum size of 0.85 m for W.C. for separate bath and W.C. facility. For combined bath and W.C. which saves floor space as well as one door, a minimum floor space of 2.2m^2 with minimum size of 12.1m should be provided. Out of many sanitary latrine designs developed in India, the hand flushed water-seal latrine has been found most acceptable to women in terms of cost, convenience, consruction, maintenance, sanitation and privacy (see Fig. 7).

While such latrines should preferably be visually segregated from kitchen, they should be located atleast at 15m distance from handpumps.



Community latrine and bath The Sulabh International, Patna (India), a voluntary organization has taken a lead in the construction of multipurpose conveniences including bathing facilities near such urban settlements. This has amply demonstrated that such public conveniences can successfully run and maintained on 'pay and use basis' by low income families. Every user has to pay Rs 0.20 (US $ 0.016 @ Rs 13 = 1$) per use. This charge includes supply of detergent cake for cleaning hands. The cost of maintenance, one caretaker and two attendants (for keeping the complex neat and tidy) is met by the collection of daily charges from the users.

Drinking water

There are generally no regular drinking water facilities in low-income settlements. Installation of handpumps (India Mark II)) have been found to be most cost-efective and can conveniently be handled even by children.

Improving water quality

Many domestic level treatments for improving water quality have been developed by NEERI, India which have gained popularity in low-income families. Such units like handpump and household water treatment system could easily be handled and managed by women (see Fig.8).

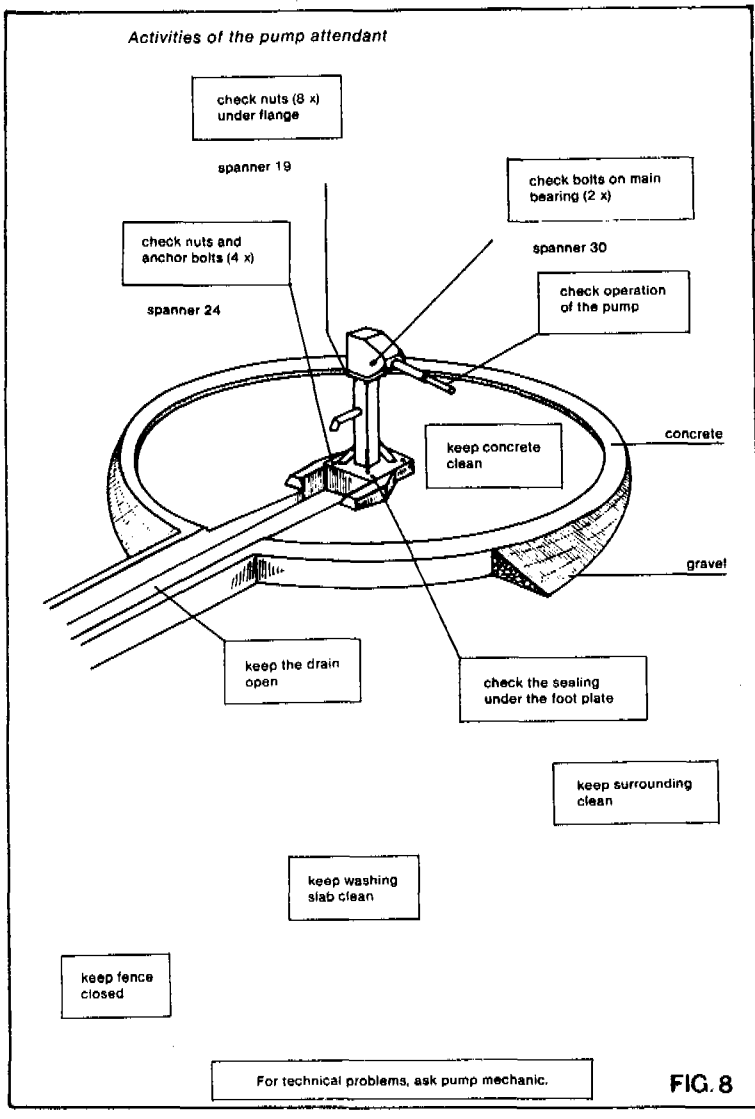


FIG.8

Due to poor environment in such settlements, water should be boiled or filtered through water filter candles fitted in household water containers (Fig. 9).

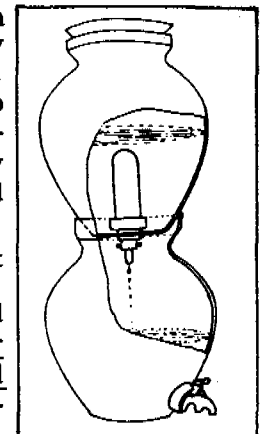


FIG.9

SUMMING UP

Transformation of development of women in low income urban settlements of self-built neighbourhood to a higher environmental standards requires an understanding of socio-cultural system and a balanced compromise between diverse needs and living style and their capacity to adopt the technology. The modern thinking is, therefore, growing for an integrated and multi-dimentional approach with the inputs of S&T, education and women's participation. The concept of 'technology package' presented here th ough has proved viable in India, it couldbe put to 'action-research' and trial by other countries. The role of women in planning for development of such settlements should be fully taken into account and this could preferably be done by specialists on women in development, women's organisations, voluntary agencies and female architects.

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Water and urban services
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Soil-cement for low cost roads

Megat Johari Megat Mohd Noor
and Azlan Abdul Aziz

Abstract

In ensuring rapid development to take place, provision of good roads is inevitable. The high cost of the conventional roads has not been very contributive. Many areas are still being served with graded latrite roads or none at all. Laterite road is notorious for being dusty during the dry seasons, causing accumulation of undesirable blanket of dust on to houses and vegetations. The dust may also have a serious effect on health. Formation of deep ruts which are unpassable to vehicles at times is a common occurance in the wet seasons. Thus a high cost is incurred if the roads are to be maintained.

The paper intends to present the works carried out at the University Pertanian Malaysia on the stabilization of lateritic soils using cement to act both as the road base and surfacing. The works include conducting basic soil mechanics tests on the soil-cement mixture and evaluating the effect of additives such as sand and rice husk ash on strength. A field trial on the construction of the soil-cement road was also done to evaluate the weathering effect under exposure.

Introduction

Stabilization of soils aims to improve or beneficially alter the properties of such soils so that they will fulfil or enhance the requirement for usage. In road works it means to satisfy the requirement of subgrade or road pavement. There are three main techniques in soil stabilization namely mechanical, physical and chemical methods. Combination of these methods may even produce a material with a higher stability or performance.

The work done in soil stabilization at the Department of Civil Engineering, Universiti Pertanian Malaysia currently centres upon soil cement stabilization with sand and rice husk ash (RHA) admixtures. The objective of the study is to obtain a low cost construction material with substantial stability for road pavement suitable for rural, urban fringes and possibly farm application. The selection of the admixtures was mainly due to the ready availability of sand and the potential of RHA as a cementing agent. A combination of mechanical and physical stabilization were employed in the study. The mechanical stabilization sets to ensure soil stability by reducing the volume of voids through compaction and alteration of the grain distribution with sand admixture. The physical methods which consist of the hydration of cement and the possible polozzonic effect of RHA provide bonding and hardening.

A selection of soil series taken from the nearby areas were utilized in the preliminary stage of the study. Soil series classification is being used because the same series and horizon requires the same amount of cement to stabilize i.e similar parent material with similar topography and climatic exposure produce soils that have similar influence on the properties of cement treated soil (ref.1). The series selected were Melaka (S1), Serdang (S2), Muchong (S3), Batu Lapan (S4) and Padang Besar (S5). Melaka series was selected for further study based upon its relatively high strength when compared with the rest and also of its lateritic nature. Lateritic nature was chosen mainly because lateritic roads are the common feature of earth roads.

This paper sets to present some of the research findings of the above mentioned work, which include the preliminary stage of utilizing different soil series and the effects of variation of admixtures on Melaka series. Field stabilization will be mentioned briefly.

Experimentals

The initial stage of the study comprised particle size distribution, index properties, compaction and unconfined compressive strength (UCS) tests performed on both untreated and cement stabilized soils. Figures 1 and 2 and Tables 1, 2 and 3 summarise the results obtained. Further tests were carried out on cement stabilized Melaka series with varying proportion of sand and RHA admixtures. The results are obtainable from figures 3, 4, 5, 6 and 7.

All the tests performed were based upon BS 1377 and BS 1924. Both the compaction and UCS tests employed 2.5 kg rammer. The UCS samples were prepared at the respective maximum dry densities based on the compaction curves obtained.

Table 1: Index Properties for Various Soil Series Studied

PARAMETERS	SOIL SERIES				
	1	2	3	4	5
Plastic Limit, PL (%)	28	23	34	23	28
Liquid Limit, LL (%)	42	36	53	42	62
Plasticity Index, PI (%)	14	13	19	19	34
Specific Gravity, G_s (%)	2.75	-	-	2.69	2.54

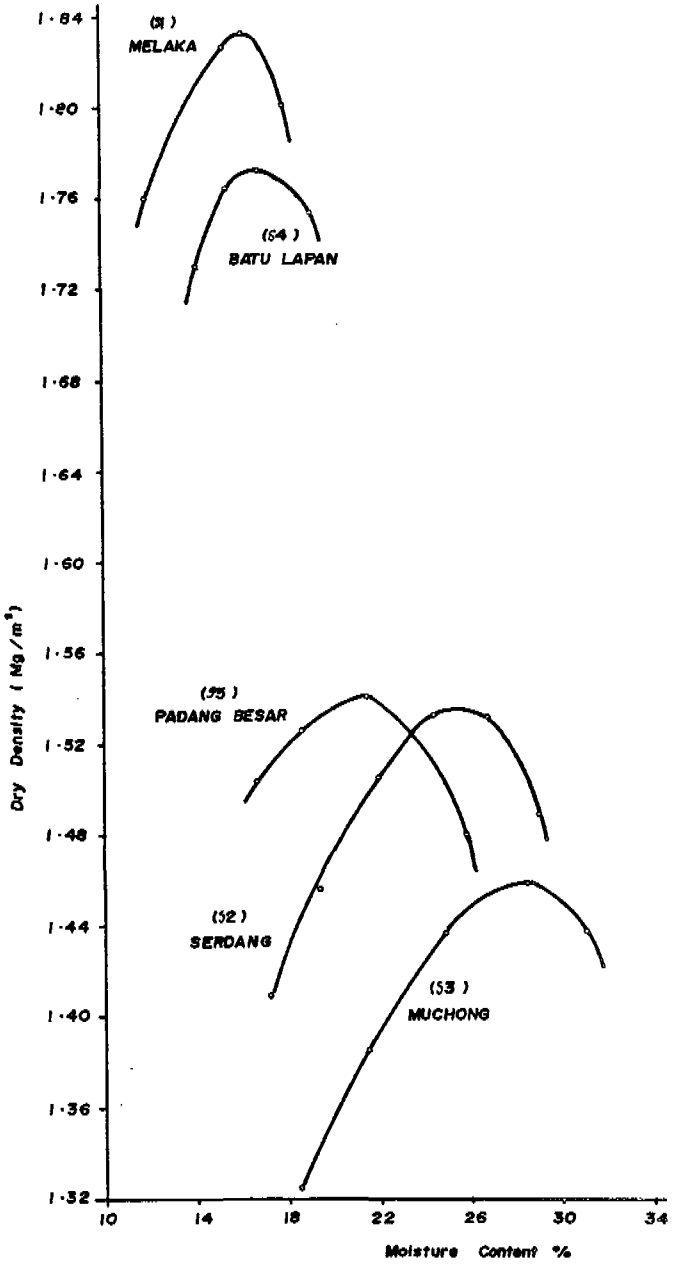

FIG. 1 Dry Density - Moisture Content Relationship for Various Soil Series

A field stabilization trial utilizing 10% cement was done to monitor the effect of weathering on the stabilized material. The six inches stabilized layer was protected by a thin layer of chipping coated with tar.

Table 2: Compaction and Unconfined Compressive Stength Tests Values For Various Stabilized Soil Series Studied

PARAMETERS	SOIL SERIES				
	1*	2	3	4**	5***
Unconfined Compressive strength 7 days, σ_7 (MN/m)	2.18	0.91	0.85	1.15 (1.07)	0.98 (0.7)
Dry density for σ_7 (Mg/m)	1.86	1.57	1.48	1.78	1.55
Compaction dry density, (Mg/m) ρ_d	1.83	1.53	1.46	1.77	1.54
Optimum Moisture Content, OMC (%)	16	26	28	17	21

Note:- All samples were stabilized with 10% cement except for: *9% , **11%, ***14% and ( ) showed extrapolated figure at 10% cement content.

Table 3: Textural Properties of The Soil Series Studied

PARTICLE SIZES (%)	SOIL SERIES				
	1	2	3	4	5
Gravel (2 - 20 mm)	49	-	-	77	8
Sand (0.06 - 2 mm)	23	67	29	10	10
Silt (0.002 - 0.06 mm)	16	7	13	3	55
Clay (< 0.002 mm)	12	26	58	10	27

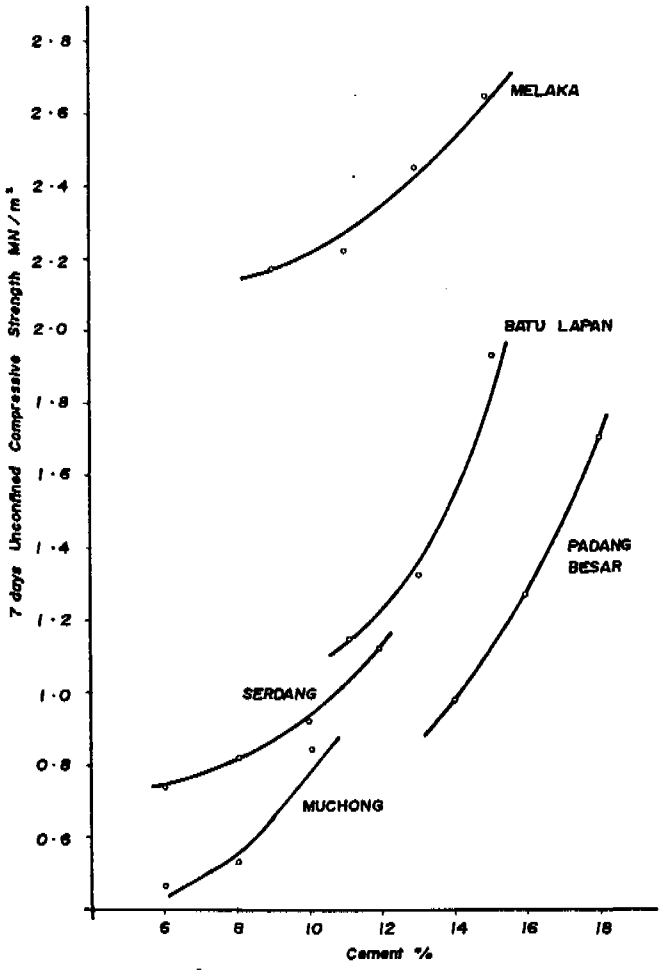

FIG. 2 Variation of UCS with Cement Content for Various Soil Series

Discussions

All soils exhibited exponential increase in strength within the narrow margin of 6 - 18% cement. Melaka series showed a remarkable initial strength achieved followed by the Batu lapan series. Judging from the compaction curve (Fig. 1) with relatively high dry density for Batu Lapan series, its initial strength is surprisingly lower than would be expected.

The Padang Besar series although obtained a higher dry density value than the Serdang series performed otherwise with regard to strength.

At this stage of the test there exist no clear relationship between the maximum dry density and the strength achieved unless the densities are significantly different. Therefore maximum dry-density cannot be used as a direct indication of strength alone. The difference in the soils characteristics as can be seen in Table 1 and 3 could have contributed to the situation.

Further tests on Melaka series with a different particle size distribution (Fig. 3) as expected gave a lower strength with 10% cement additive. The later stage utilized a soil type with 75% fines.

Seven fold increase in strength was achieved with the addition of 10% cement as can be seen from Fig. 6. Inclusion of 10% river sand showed a further 25% increase. However with further increment of the sand content resulted in lower strength attained even-though with linear increase in dry density. The average unconfined strength with 10% cement exceeded the recommended 1.72 N/mm^2 for cylindrical specimen (ref.2). Sand admixture would be a useful additive for those soils which do not meet the required standard.

All the results obtained shown in Fig. 7 utilizing RHA admixture are below the above mentioned limit even with 10% cement mix. The variation in the strength of 10% cement stabilized soils could be attributed to the difference in operators employed. Addition of RHA was thought to improve the strength by combining with the lime in the cement but

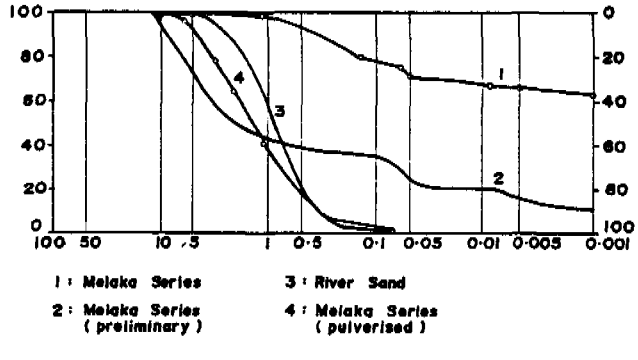

FIG. 3 Dry and Wet Sieving of Melaka Series and River Sand

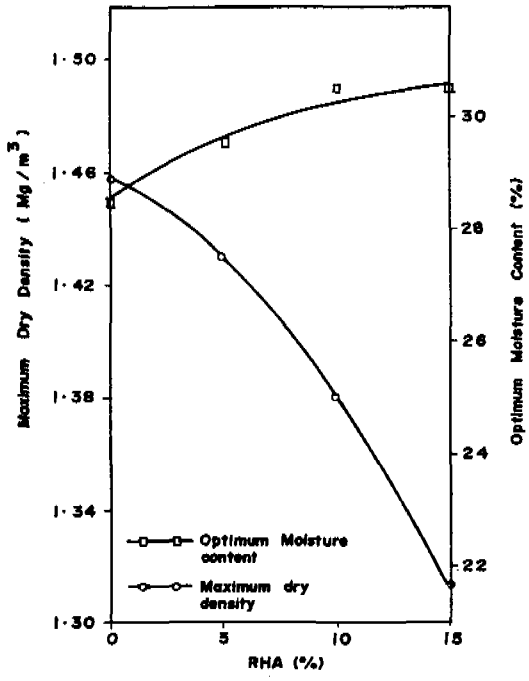

FIG. 4 Variation of Maximum Dry Density and Optimim Moisture Content with Varied RHA Content for Melaka Series with 10 % Cement Mix

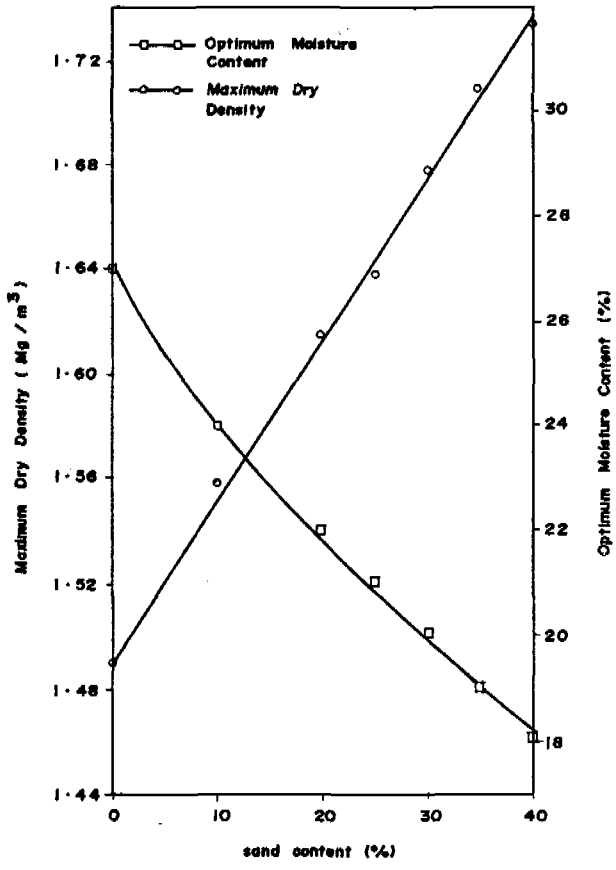

FIG. 5 Variation of Maximum Dry Density and Optimum Moisture Content with Varied Sand Content for Melaka Series with 10 % Cement Mix

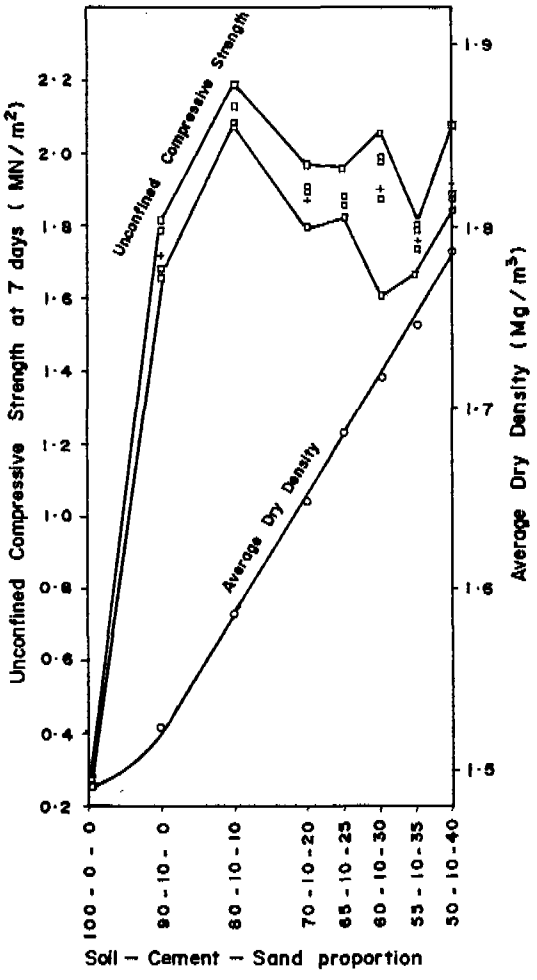

FIG. 6 Relationship between Compressive Strength and Dry Density with Various Sand Mix Proportion

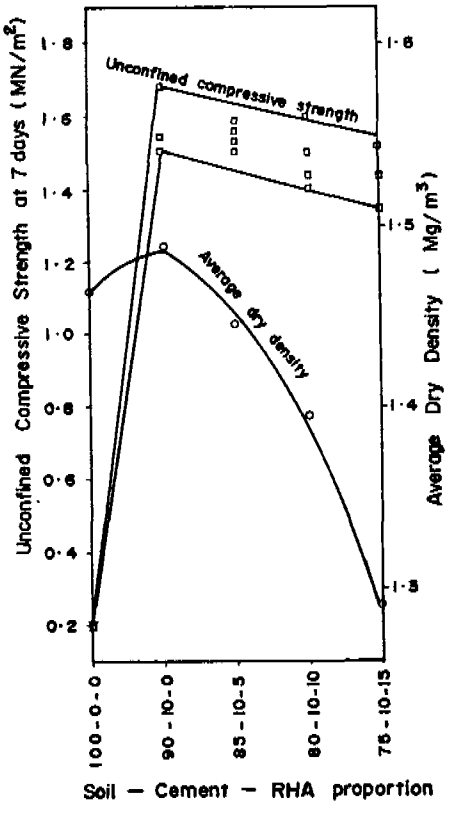

FIG. 7 Relationship between Compressive Strength and Dry Density with Various RHA Mix Proportion

proved otherwise. Substantial decrese in the dry density with increase in RHA content may have affected the strength obtained. RHA may however be used in areas where the initial moisture content is much higher than the optimum moisture content based upon its ability to hydrate the water content as shown in Fig. 4.

The trial stabilization plot still remain intact after 9 months of exposure without any change in moisture content. Samples extracted were very brittle.

Conclusion

Dry density alone cannot be used to gauge the strength of stabilized soils. Soils of the same series but of different horizon exhibit different characteristics including stabilized strength. Cement stabilization can improve the strength of the soil tremendously. Addition of sand admixture will increase the strength further. RHA is not an effective admixture for improving the strength but can be employed to enable the moisture content of wet soils be at the optimum. The trial plot remain intact with unchange in moisture content during the wet season gives some indication of the ability to resist weathering.

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14th WEDC Conference

Water and urban services in Asia and the Pacific

Kuala Lumpur 1988

Squatter area upgrading in Malaysia

Dr R M Bradley and C D Ponniah

EXISTING SITUATION

Socio-Economic Status

In the Federal Territory of Kuala Lumpur the 1985 squatter population was estimated at 200 000 persons, occupying 1189 ha. There were about 200 settlements, containing 29000 dwellings, generally dispersed along the banks and flood plains of watercourses and along highways and railways.

The squatter population increased at an average annual rate of 11% from 1967 to 1977. With an acceleration of resettlement schemes the population decreased at 3.2%/year from 1978 to 1985 and at 6.6%/year from 1982 to 1985. 60% of families were below the threshold poverty level of M$500/month (December 1985 M$2.5 to US$1.0).

Water and Sanitation Facilities

In the Federal Territory in 1985 piped water supply was available to virtually the whole population. About 20% of the total population of 1.21 million were served by non-sewered sanitation systems.

Field surveys were carried out in six representative squatter settlements with a total population of 20516 and 2576 families. Families visited and facilities inspected ranged from 5 to 15% of the settlement total.

Water Supply was primarily from a public standpipe. Some shallow wells were still in use but not for drinking. On average, each standpipe served 10 to 12 dwellings, often by means of a plastic hose which was shared among families. There was little evidence of manual carrying of water over long distances. It was conclued that about 90% of dwellings were receiving a reasonably safe water supply, although improvements could still be made, particularly to reduce risks of contamination within the home.

Excreta disposal was generally to some type of latrine, either pour-flush (44% population), overhung (5%) or dry privy (44%). About 10 to 15% were communal. The standard of cleanliness of shared facilities was high, reflecting a high level of social awareness and good community organisation and leadership. The main inadequacy, which was prevalent in almost all areas, was that the latrine discharged to a shallow depression or marsh or to a drain (ditch, pipe or corrugated sheet) which in turn discharged direct to a watercourse or to a seepage pit. The latter was often provided with insufficient seepage holes or constructed in soil with a low permeability. It was estimated that about 80% of all excreta reception facilities associated with pour-flush latrines and pit privies were unsatisfactory, although not all to the same degree. 2% of the population had piped water and flush toilets and 5% relied on indiscriminate defeacation or disposal with refuse.

Sullage disposal in all squatter areas was to drains and although it presented no major health risk the situation could be improved by upgrading site drainage and eliminating depressions under houses which tended to collect water and give rise to vector breeding.

Nightsoil buckets were still used by about 30000 people although they had been phased out in squatter settlements some years ago. In 1985 there were about 5400 buckets, serviced on alternate days by City Hall and a licensed private contractor, compared to about 30000 in 1970.

The house bucket contents were tipped into a separate bucket which was carried to the collection truck. Although the collection bucket was washed at the truck, house buckets were not washed by the collection crews. In general the buckets contained only excreta and, depending on user preference, water used for anal cleaning. In some areas anal cleaning was carried out in a separate washing area and the water discharged to the surface drainage system. Newspaper was the preferred cleansing material in some cases, and the buckets filled relatively quickly as a result. Site visits showed that the collection system was efficient and as hygienic as possible with little spillage. Inspections of bucket locations indicated a lack of attention to fly protection and cleanliness, particularly in some of the communal facilities. Access doors were invariably poorly fitting and few buckets were provided with lids. Fly larvae were present in the nightsoil.

All nightsoil was discharged to sludge digesters at the Pantai Sewage Treatment Works.

Public Health Status

The infant mortality rate in Peninsular Malaysia in 1983 was 20/1000 live births, having fallen from 50/1000 in 1965. The rate for the Federal Territory was even lower, at about 13/1000. Water related disease rates in the Federal Territory had also fallen with 1.48 notified cases/ 100 000 population of typhoid, cholera and dysentery in 1983 compared to 10.82 cases/100 000 population in 1972.

A 1978 survey (ref. 1) of 4 to 6-year old children in Kuala Lumpur showed a significantly higher incidence of parasitic infestation in squatter setlements (ascaris 60%, trichuris 84%) compared to "upper middle class" areas (ascaris 2.5%, trichuris 8%). Survey data for children and adults in Kuala Lumpur in 1982 showed that communities in sewered areas exhibited an infestation rate about half of that in non-sewered areas, as summarised in Table 1 (ref. 2).

Diarrhoea records for 1984 for children up to 7 years old were analysed for 11 clinics in squatter settlements and compared to data from 2 large clinics in urbanised sewered areas. Cases in the sewered areas represented 2.5% of the total attendance of 38710, compared to 2.6% of the total attendance of squatter clinics, suggesting that diarrhoea rates were not related to the type of excreta disposal system.

The major sanitation deficiency in the squatter areas was in the excreta reception system which could explain to some extent the relatively high prevalence of parasite levels in non-sewered communities. However, this did not imply that the absence of sewers, per se, was the cause of the higher incidence rates.

UPGRADING STRATEGIES

Government Policy

City Hall policy is to phase out all bucket nightsoil systems by 1990 and to accelerate the urban renewal and squatter relocation programme to achieve completion by about 2005. Emphasis is placed on privatisation of squatter area redevelopment including in-house water supply and sewerage. Any interim upgrading of water and sanitation facilities must, therefore, be prioritised in the context of the overall squatter settlement eradication policy.

Upgrading Requirements

Perceived problems by squatters were evaluated from a sample survey to determine upgrading and improvement priorities. The main complaints were no electricity (41%) and no in-house water supply (40%). Only 5% considered excreta disposal facilities inadequate.

Public health risks were not quantifiable. With the exception of critical areas such as those without easy access to piped water, no formal means of excreta disposal, locations where excreta was deposited directly on the ground surface and in bucket nightsoil areas, upgrading could only be justified on the basis of enhancement of environmental quality.

Recommended Upgrading Measures

Water supply upgrading was based on one standpipe/10 dwellings, each standpipe to comprise three 12 mm taps. The maximum distance would not exceed 50 m. The use of shared hoses connecting standpipes to dwellings was encouraged since it obviated the need for hand carrying and reduced the risk of contamination. Recommended improvements were lifting hoses above the ground and not submerging hoses in water storage vessels, thereby avoiding potentially contaminated water being drawn back into the mains supply during periods of low pressure.

TABLE 1. Parasitic Infestation Rates

Area	Infestation Rate (% Positive)			
	Ascaris	Trichuris	Ancylostoma	Overall
Sewered Areas:				
New Villages	11	28	4	33
Flats	5	20	2	23
Average	8	24	6	27
Non-Sewered Areas:				
Squatter	31	50	8	58
Estates	46	50	22	65
Average	38	50	15	61

Sanitation upgrading in squatter areas was based on pour-flush latrines with relatively shallow gravel trenches or raised mounds for soakaways because of adverse drainage conditions. The total cost of a pour-flush latrine including a small septic tank of two 1m dia., 1m long concrete pipes was about M$1000.

Bucket nightsoil upgrading was to provide sewer connections where street sewers were close by, or vacuum cartage. For vacuum cartage, the buckets would be replaced by a 1.5 cu m watertight vault costing M$320, sufficient for three weeks use. The bucket lavatory would be upgraded, preferably to a trapped squat plate. Seven tankers would be required and it was recommended that existing tankers be modified by removing the internal dividing wall and installing a vacuum pump and 100m hose.

RATE OF IMPLEMENTATION OF UPGRADING STRATEGIES

Squatter Areas

The recommended programme was to provide 290 standpipes and 2860 pour-flush latrines to replace overhung latrines and to provide excreta disposal facilities for those families who had to rely on indiscriminate defeacation or disposal with refuse. The total capital cost of such priority upgrading was estimated at M$0.5 million for the standpipes and M$2.8 million for the pour-flush latrines. The number of squatter families to benefit from the provision of standpipes would be about 2900 at a cost (excluding flexible hose) of M$170/family. The cost of the pour-flush latrine would be about M$1000/family, assuming no sharing. The upgrading work could be completed in three years, including one year for detailed site surveys.

Nightsoil Areas

To eliminate bucket nightsoil systems by end 1990 about 2500 buckets would be converted to sewerage at an average cost of M$2500 and about 2900 buckets converted to vacuum cartage at an average cost of M$740 (range M$320 to M$920). These costs allowed for 70% of the bucket toilet buildings having to be completely rebuilt and excluded the cost of tanker modification. The estimated operation and maintenance cost of a vacuum cartage system would be M$7.4/vault per month, compared to M$8.6/house per month of the bucket nightsoil system.

FINANCIAL VIABILITY

A pour-flush latrine would represent about 4.5% of a monthly income of M$500 if it was to be financed over a 5-year period at 10% interest. Increasing the payment period to 10 years would decrease the repayment to about 2.7% of the monthly income. The cost to the family could be reduced if materials were provided, either free or at a subsidised cost, and if the squatters were to provide their own labour. The material costs of a pour-flush latrine, averaged about 75% of the total cost. Experience showed that effective community organisation could be achieved in squatter areas, and the field survey showed that such organisation was capable of ensuring clean and hygienic communal latrine facilities.

It was recommended that the possibility of community participation in construction be explored, together with the provision of mateials by Government. The concept of Government assistance in other sectors was already accepted, and since the Government's goal was to upgrade or redevelop squatter areas generally, the principle of financial assistance for facilities designed to safeguard public health in critical areas was sound; either through direct grant or cross subsidy from the more affluent sewered areas. Such financial assistance would be essential for the lower income nightsoil areas where conversion to sewerage was to be carried out.

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Urban project development trends - Philippines

Alistair Wray

INTRODUCTION

This paper reviews the urban development projects that have been undertaken in the Philippines in terms of objectives, components and implementation experience, and suggests approaches that may be considered in the future to address the problems of rapid urbanisation.

To date, international aid agency funding has been provided by the World Bank through five separate loans. In addition, UNICEF has a growing programme of activities in urban areas nationwide; there has been a certain amount of bilateral aid for low income housing; and, there have also been national housing programmes implemented through the Ministry of Human Settlements and the National Housing Authority. Given the scale of the investment, this paper will focus on the World Bank assisted projects. My own experience has been related to the three most recent, which are now in various stages of implementation.

URBAN PROJECT DETAILS

Capital City Investment

The main components and details of these World Bank urban projects are given in the table attached.

The first project focused on shelter in Metro Manila and was one of the World Bank's early experiences in progressive development housing with the emphasis on the provision of tenure, basic services and housing materials loans and the promotion of small businesses. Its implementation has been well documented (ref. 1,2,3) and is generally deemed to have been successful. Self-help construction was relatively efficient, impacts on housing stock and socio-economic conditions were favourable and the project affordable and accessible to target populations not hitherto served. While the appropriateness of progressive development projects was demonstrated, there were delays in implementation and organisational problems, which increased costs and threatened affordability. Additionally the poorest households were unable to participate and there was under-utilisation of the materials and business loans.

This experience encouraged further use of this type of project, but with efforts at reducing costs and standards still further, making provision for rental accommodation to serve the poorest families and improving the institutional arrangements in order to speed up implementation.

The second urban project therefore reinforced this approach with the provision of basic needs in further low income housing areas in Metro Manila, together with smaller upgrading projects in three other Philippine cities, with the aim of building up the capability to implement shelter projects outside the capital area. Slow rates of land acquisition and implementation were again experienced, together with difficulties in subsequent cost recovery, but the principles of the approach were again validated.

The third urban loan concentrated once again on Metro Manila and focused on the upgrading of a number of squatter areas throughout the capital and also a large number of 'grey' areas where land tenure was not a problem but where basic infrastructure services were lacking. This was an attempt to speed up implementation and address serious deficiencies through the rapid letting of a large number of small, appropriate infrastructure contracts as part of a rolling programme. It also included an important planning and budgeting exercise for the capital which attempted to coordinate the efforts of various agencies and prioritise projects for the allocation of limited funds (ref 4). The project did indeed proceed quickly, but, as it concentrated once again on the capital, did nothing to

WORLD BANK DEVELOPMENT PROGRAMMES IN THE PHILIPPINES (1976 - 1987)

Costs in US $ Millions

Date and Project	Location	Total	Loan	Main Components
1976 Manila Urban Development Project	Metro Manila	65	32	Upgrading of infrastructure and community services to some 15,000 structures in the Tondo Foreshore area together with 3,000 sites and services units, provision of housing materials loans, assistance to small businesses and development of various key transport links.
1979 Second Urban Development Project	Metro Manila and three other cities	70	32	Provision of basic needs of more than 180,000 low income people in Dagat-Dagatan, Metro Manila, and in three secondary cities. Also employment promotion in Dagat-Dagatan.
1980 Third Urban Development Project	Metro Manila	120	72	Upgrading and provision of tenure in 13 priority areas, provision of basic services to numerous deprived areas, sites and services on 79 ha, small business assistance and training programmes.
1983 Regional Cities Development Project	Four Regional Cities	115	67	Multi-sectoral urban project to reduce infrastructure bottlenecks to economic development in four regional cities, providing basic urban services and improving local management capabilities.
1984 PREMIUMED	Fifteen Urban Centres	69	40	Assistance to local governments in providing infrastructure and municipal services through the establishment of a revolving municipal development fund and establishment of a central office to assist local government in project preparation and inplementation.
1984 Manila Urban Development Project Supplement	Metro Manila	-	10.5	Supplementary finance to the 1976 Manila Urban Development Project.

stimulate development in other regions of the country. It also continued the theme of investment in the housing sector and supporting infrastructure.

Regional City Investment

These projects tended to emphasise the primacy of Metro Manila over other cities and increase its attraction, especially for displaced rural workers. In an attempt to redress this imbalance, the Philippine government identified four key regional cities with potential for growth and prepared an investment programme to stimulate this growth. This formed a regional development strategy which addressed not only low income housing needs, but also key deficiencies in basic municipal infrastructure and facilities and sanitation problems. It aimed at the improvement of urban management in areas such as planning, budgeting and finance, and in the provision, operation and maintenance of essential services and infrastructure. This, it was hoped, would remove bottlenecks to economic development and stimulate these regional cities as a counterbalance to Metro Manila.

The wide range of projects in each package necessitated the involvement of numerous national agencies as well as the concerned local governments. Coordination was carried out centrally through the National Economic Development Authority (NEDA) but implementation was undertaken through local city project offices in each of the four cities, working closely with the different branches of the local government. The innovative nature of the project, the number of agencies involved and the complex division of responsibilities did create problems of coordination with resultant delays, which were further exacerbated by the overall economic situation in the country, but the programme did move ahead, implementing projects in a wide range of sectors (sites and services and upgrading areas; roads, bridges, drainage and landfill sites; market rehabilitation and construction, slaughterhouse and bus terminals; maintenance workshops and equipment procurement), providing substantial employment in the cities. Action programmes were also initiated in areas such as municipal finance and budgetting, the management of municipal enterprises and the operation and maintenance of municipal infrastructure and municipal services. Once again land acquisition and coordination between the concerned agencies and the local governments tended to delay the shelter based projects and mini-industry schemes, and it was the projects in the local government sector of responsibility, particularly the municipal enterprise components (markets, slaughterhouses and bus terminals) that were implemented most quickly. Local interest in these particular projects was high as was the resulting impact, with the rate of implementation dictated only by availability of local counterpart funds. As these projects were revenue generating, the drain on local resources was minimal and their implementation helped to strengthen the overall financial management and the operation of municipal enterprise schemes. The experience with locally-based offices was also favourable and the close ties with other local government departments assisted in promoting the desired improvements in municipal operations and management.

However, it was clear that the scale and rate of implementation of the shelter programme would have to be greatly increased if it was merely to maintain the status quo, and the long preparation times, land acquisition difficulties and high administrative costs were in many cases out of proportion to the capital investment and resultant areas of improved housing.

Implementation of both national and local infrastructure components was straightforward but clearly most effective when tied to other projects, particularly as all new infrastructure represented additional operating and maintenance requirements, in situations where much could be done to improve the management of existing infrastructure.

Overall this multi-sector project demonstrated the many benefits of a balanced approach to meeting the deficiencies in the cities, and allowed the project packages to be tied closely to the cities' priorities and ability to pay and raise additional revenues. The use

of the local project offices was also seen as an effective way of improving city management capabilities.

Investment in Other Urban Centres

Some of these points were taken up in the fifth urban loan which the Government used to assist in providing needed infrastructure and municipal services, but not shelter projects, to a range of smaller urban centres through the establishment of a revolving development fund. A greater central government role was required in this case to assist these smaller local governments in preparing, evaluating and implementing the projects. Fifteen urban centres of differing sizes were identified and a rolling programme of projects prepared. Various centres are now implementing projects, although others have found it difficult to raise the necessary counterpart funds and have dropped out while additional centres have been slow to come forward resulting in delayed implementation. This has resulted in underutilisation of the development fund and a rather piecemeal approach to investments, particularly when considered in the regional context. In addition, the central government office proved to be too remote for its role of assisting local governments with what are essentially small projects, and had limited impact on improving municipal management.

The Government is now considering the strategy to be adopted for further urban project development.

FEATURES REVIEWED

The experiences stemming from these urban projects have already given rise to a series of responses and shifts in emphasis by the Philippine Government.

There was the early emphasis on Metro Manila and shelter; the adoption of smaller projects to speed implementation; the switch in emphasis to various regional centres to counteract the rapid growth of Manila; the adoption of a broad based multi-sector approach to spur development in selected urban centres; the devolution of many implementation responsibilities to local centres to build up local capabilities; and finally, the creation of a funding mechanism which would enable local governments to propose their own projects. However, these developments must be viewed against the background of rapid urbanisation, the limited ability of local and national governments to respond and provide the services required, and the need to plan urban development strategy whilst having regard to the potential of different regions. This suggests that implementation lead times must be reduced further, and the process made more flexible and effective with the strengthening of the regional approach to urban development.

FUTURE STRATEGIES

Role of Regional Offices

This regional approach could be effected through the establishment of regional offices tasked with the review, analysis and development of urban strategy within the region. Policy would still be formulated at the national level, but the regional offices would support the local governments in developing structure plans which could be translated into short term action programmes and longer term frameworks for urban growth. Local governments would be able to propose projects but these would be reviewed in the regional context and the local governments assisted in their preparation.

High priority projects could be quickly picked up under the short term action programmes, and if revolving development funding was also controlled at the regional level, these offices would have the financial and organisational ability to implement projects in a short time-frame, thus maintaining the interest and support of local officials.

While assisting in planning, project implementation and financing, the underlying function of the regional offices would be to increase urban efficiency and to ensure it is not stifled by rapid urban growth. Project implementation will assist in this as will the close contact with strong technical teams in the region. Futhermore, project implementation should be linked to improvements in various financial and operational performance indicators to encourage increased efficiency in municipal

management and operations, and make expenditures more effective while strengthening the revenue base.

Role of the Project Components

Revenue generating municipal enterprise components such as markets, slaughterhouses and bus terminals can be implemented relatively quickly, have high impact and if properly operated require only limited amounts of scarce local funds. They provide good vehicles for improving operating procedures and fee collection performance. As such, where justified they should be implemented as priority projects. The Regional Offices would be able to assist in promoting the regional approach and avoid piecemeal developments, and be able to evaluate projects such as a large slaughterhouse or wholesale market in a wider regional context. Assistance could be given to small local governments in counterpart funding and preparation of schemes beyond their financial and technical capacity.

Infrastructure investment should also be vetted in the context of regional plans; potential for stimulating growth; and support provided to other projects. New capital expenditure on local infrastructure should be appraised critically, as frequently minor investments in items such as simple traffic management measures and maintenance operations can have a more marked effect on improving city efficiently and management.

Shelter and basic needs provision deserve special consideration. The present approaches, whether through the national agency or local governments, are well prepared and efforts are made to tailor standards to affordability and vet beneficiaries correctly, but the resulting preparation times and frequent poor cost recovery means that the volume of housing handled does not keep up with demand and squatter areas continue to proliferate. Much greater involvement and encouragement of the private sector in true low income housing might be the only solution to meeting demand. The private sector may already be involved in self-help housing and house improvements in these areas, but is there any reason why they cannot be more involved in the site development and subsequent operations and collection processes, with government involvement limited to land acquisition, and establishing guidelines for planning and services levels and affordability. The provision of cheap funds to private developers linked to performance guarantees might mobilise the necessary housing efforts, with coordination undertaken by strengthened regional offices. It does appear that it will only be through maximising private sector involvement in all aspects of low income housing, by means of appropriate incentives, that throughput will approach the desired levels.

Much of this argument for greater private sector involvement also applies to other aspects of urban development. Clearly, municipal enterprise development and operations are well suited to private sector involvment, as are services such as solid waste management and infrastructure maintenance. The management of the revolving development funds themselves may best be handled by private banks and finance houses, and help mobilise additional private finance.

CONCLUSIONS

It is hoped that the above observations might encourage discussion into possible approaches to urban project development in the Philippines and also in other countries at similar stages of urban development. However, the views expressed in this paper are personal and do not necessarily reflect the opinions or policies of the Philippine Government or of any involved national or international agencies.

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14th WEDC Conference

Water and urban services in Asia and the Pacific

Kuala Lumpur 1988

Services for urban low income housing

Andrew Cotton and Richard Franceys

1 INTRODUCTION

This paper addresses problems and issues in the provision of infrastructure for low income families on sites and services schemes in urban areas. 'Infrastucture' or 'Services' within the context of this paper refers to:

The provision of drained land.
Stormwater drainage.
Water supply.
Sanitation and household wastewater disposal.
Roads and suitable access.
Solid waste disposal.
Power supply and street lighting.

The case study material is drawn from experience of the 'Million Houses Programme' (MHP) implemented by the National Housing Development Authority (NHDA) of the government of Sri Lanka. The approach of the MHP has been strongly community-orientated in the respect of house construction. Families are provided with loans for house construction; determining the beneficiaries' priorities in housing has helped to reduce the costs and enabled a wider coverage to be achieved, in addition to mobilising the resources of the communities and households involved.

This paper describes a project in the southern Sri Lankan city of Galle, which proposes a model for the delivery of sustainable urban services for housing programmes in centres outside of Colombo, the capital city of Sri Lanka.

2 DIFFERENT APPROACHES

Government agencies have evolved different approaches to the provision of shelter and services for low income families. Examples are: local or central government agencies provide serviced housing for rental; families build their own houses on a plot which is provided with a water tap, mains sewerage connection, and power supply; communally serviced plots on which families build their own housing but have access only to communal toilets and public standposts. The impact on infrastructure of these different approaches is significant.

There are numerous situations in which infrastructure has been designed to provide a far higher level of service than is necessary, perhaps through arbitrary adherence to inappropriate standards and codes. Kirke (1986) quotes the case of a master plan recommending a totally unrealistic water supply of 500 litres per capita per day for a Cairo. Laquian (1983) comments that high levels of service and design standards has led to high infrastructure costs in some World Bank projects, where water supply and sanitation have accounted for 60% to 80% of infrastructure costs. The WHO (1987) quotes capital costs per person of sewerage in the range US$ 80 to US$ 150, whereas on-plot improved pit latrines are much cheaper at US$ 13 to US$ 30.

If services are to be sustainable, the key issues are:

1. Recovery of capital and maintenance costs.
2. Ensuring effective maintenance.

Keare (1987) suggests that implementing agencies have put a higher priority on service levels than have the beneficiaries; Tolley et al (1987) concluded that there is evidence to support smaller projects which respond more directly to the needs of the consumers.

Cotton and Franceys (1988) considered these implications and identified five principles -the "Five I's":

INCREMENTAL IMPROVEMENT - provide an initial level of service, which is much lower than conventional design standards imply, to meet the basic needs at reduced cost. The level of service can subsequently be upgraded as and when required.

INVOLVING PEOPLE - consult the community and involve them with the provision and improvement of infrastructure (in a similar fashion to their involvement with aided self help housing).

INDIVIDUAL SERVICES - the opportunity for recovery of both capital and recurrent costs of services is partly dependent on whether services are provided on a communal or individual basis.

INCOME RELATED - provide services which reflect the ability of beneficiaries to pay for those services; if it is not affordable it cannot be maintained.

INSTITUTIONAL - involve fully the urban local authorities who ultimately adopt the schemes.

Consideration of the "FIVE I's" requires alternative implementation strategies to be considered; the approach has greater flexibility than the traditional way of working to arbitrary standards which by-pass the beneficiaries.

3 INFRASTRUCTURE FOR THE MHP

Prior to the instigation of the MHP in Sri Lanka, because of the number of agencies involved in urban improvement, no coherent policy governed the quality or quantity of the physical infrastructure. Early schemes of the MHP implementing agency generally provided expensive high levels of service constructed by contractors.

Whilst priority was given to the recovery of housing loans, it is unfortunate that no consideration was given to cost recovery of infrastructure. Initial capital costs were very high, with little chance of recovery directly or indirectly; little consideration was given to maintenance.

Subsequent policy has considered an options-based, incremental improvement approach (Cotton & Franceys 1986). This defined different levels of service appropriate to particular communities at particular times.

A PRIMARY LEVEL of infrastructure is paid for by the initiating agency without cost recovery. It provides the absolute minimum level of services required before people can move on to the site to commence house construction. Capital costs are considerably reduced.

The primary level services can subsequently be upgraded during an INTERMEDIATE PHASE according to the priorities and resources of individual families and communities, financed by recoverable loans. This will eventually lead to an ULTIMATE LEVEL of service, which is likely to take many years to achieve.

4 THE GALLE PROJECT

The Galle project involves both new housing (sites and services) and upgrading of existing housing. By the end of 1988 it is hoped that about 700 families will have benefited from the programme.

Galle Municipal Council (GMC) will continue to be responsible for the provision of city-wide trunk services. On the sites and services schemes it is assumed that GMC will only be responsible for PRIMARY LEVEL services. Table 1 indicates these services and their estimated costs. The responsibility for subsequent upgrading of the level of service rests with the individual households and the community served.

There has to be a mechanism by which upgrading can occur. Community Development Councils (CDC's) have been established on the urban housing schemes in Colombo, and represent the community in dealings with the housing authority. In the Galle project, the CDC (which is effectively a new tier of management) will ascertain and implement the community's wishes regarding the level of service provision.

A "shopping list" of service improvements can be drawn up showing the effect on household finances; this will assist communities in deciding their priorities. A specific example has been worked out for a small sites and services scheme which forms part of the Galle project. Table 2 shows the cost per household in US$ of upgrading the primary level infrastructure; typical household incomes are in the range $20 to $70 per month; the monthly charges include amortization and interest.

Both the community and the individual households can determine their own priorities. Metered water and power connections can be purchased by households; the CDC will decide whether there is sufficient demand to upgrade communal services such as drain lining and road surfacing. Funds for improving the services beyond the primary level are loaned by the Municipal Council to the CDC. Repayment of these loans to the council will provide a revolving fund for further upgrading.

All too often, national agencies implement infrastructure projects in isolation from the municipal authorities who will have to adopt, operate and maintain the schemes. Keare (1987) states the need to design projects within the local public financial context; Bahl and Linn (1987) observe that "turnkey" projects can burden local authorities with facilities which they cannot operate or maintain. An important feature of the Galle project is that infrastructure work is being implemented through the municipal council, taking into account their capacity for maintenance. Whilst this may appear to slow down the implementation of new projects by involving another layer of administration below the housing authority, the long term success of the schemes is largely dependent on successful adoption by the maintaining authority.

The Galle project is funded by the UK Overseas Development Administration; the costs of primary level infrastructure and loans for service improvements are being provided. In principle, the cost of primary level infrastructure would be derived from local authority rates.

There are also significant financial advantages in the approach described above. Previous analyses by Cotton and Franceys (1986) have illustrated the large difference in lifetime cost between different approaches to infrastructure provision. For a sites and services scheme in Colombo, the comparison was made between:

Approach 1. High levels of service from the outset, constructed by the implementing agency's contractors;

Approach 2. Primary level infrastructure at the outset followed by upgrading through loans.

The lifetime cost was reduced by 52% in alternative 2; equally importantly, the cost recovery potential is increased from 12% to 52% of the lifetime cost. The total cost to the implementing agency is reduced by 77%

5 CONCLUSIONS

Implementation of sites and services schemes in Galle, Sri Lanka,involves:

1. Providing a much lower level of service at the outset with the possibility of planned upgrading in the future.

2. Involvement of the community in taking individual and collective responsibility for their priorities in improving services based on what they can afford. Community level affairs are managed by an additional tier of management, the Community Development Council.

3. Recovery of the costs of higher levels of service through the provision of loans from the Municipal Council to families and the Community.

4. Service levels which relate to the ability of the beneficiaries to pay.

5. Full cooperation of the Municipal Council in planning, design, implementation and maintenance of the infrastructure.

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Table 1 OPTIONS FOR INFRASTRUCTURE DEVELOPMENT

	PRIMARY Grants	IMPROVEMENT Loans
GROUND PREPARATION	all ground compacted to above one in five year flood level and graded to slope for drainage average US$100/HH served	landscaping and planting in public and semi-public areas
DRAINAGE	lined sullage drains, earth storm drains average US$32/HH served	all drains lined average US$17/HH served
ACCESS	earth/gravel roads, emergency vehicle access to each house average US$8/HH served	surfaced macadam average US$60/HH served
WATER	single standpost per 30 households average US$5/HH served	household connections with informal storage average US$40/HH served
SANITATION	household toilets with on-site leaching tanks, temp. superstructure average US$50	same, but with permanent superstructure average US$67 extra
SOLID WASTE	single transfer bin per 40 households average US$1/HH served	single transfer bin per 20 households average US$2/HH served
POWER	access for future overhead line	overhead lines, street lighting, house connections average US$260/HH served
COMMUNITY	community centre building average US$33/HH served	

Table 2 HOUSEHOLD LOAN REYPAYMENTS
Costs in US $

ITEM	LOAN	MONTHLY CHARGE	CUMULATIVE MONTHLY TOTAL
Housing loan	333	2.9	2.9
Maintenance of house		0.8	3.7
Local Authority rate		0.1	3.8
Sanitation: pit latrine	117	2.2	6.0
plus maintenance		0.1	6.1
Water: connection	38	0.7	6.8
tariff		0.5	7.3
Road surfacing	60	1.1	8.4
Drain lining	17	0.3	8.7
Power: connection	260	5.0	13.7
tariff		3.3	17.0

14th WEDC Conference

Water and urban services
In Asia and the Pacific

Kuala Lumpur 1988

Water pollution and control measures

Professor Che Xianxin and Bai Yongjiu

LIAONING WATER POLLUTION & CONTROL MEASURES

I. Water situation in China

With her more than one billion people, almost one quarter of the world's total population, China is the most populous country, but her social and economic development is uneven due to the historical reason.

Comparing with U.S.A., China's population density is higher. There are more than twenty cities with population of more than one million in China, but in contrast there are only six cities with populations of more than one million in U.S.A. Urban population varies from about 6% in the remote provinces to more than 67% in others. The density of population varies from less than 2 persons per sq.km. (Tibet) to more than 1900 (Shanghai). Ninety percent of the total population living on only 17% of the land.

Concerning natural conditions, China is similar to U.S.A. on the geography and climate, annual precipitation ranges from more than 1600 mm in the southern coastal areas to about 600 mm in central area of the country to less than 200 mm in the northwest. China ranks among the lowest of nations in surface water resources per capita.

(see Table 1)

Among 0.8 billion rural population in China, only 0.3 billion have access to safe water supply, of which 15% is piped. The other 0.5 billion of rural population have problems with drinking water, including 45 million people who are supplied with water containing excess flourides, 60 million who depend on brackish waters, 150 million who draw on polluted surface water that are not adequately treated and 50 million who do not have adequate source of water.

Due to the high density of the population, uneven economical development, deficient water source and population control, water borne infectious diseases such as dysentery and hepatitis which are common in developing countries are also common in China.

So the deficient water source has already obstructed the development of industry, agriculture, economics and resident's health, especially in some rapid developing metropolis like Shanghai, Beijing, Tianjin, Shenyang and Dalian.

II. General description of Liaoning Province

A. Population and economics. Liaoning is a coastal province in the northeast of China with a total population of 36.29 million persons living in an area of 145,700 sq.km. with a density of 249 persons per sq.km., it is amongst the most heavily urbanized provinces.

(See Table 2)

There are four super size cities with over one million people among the 22 in the whole nation.
Liaoning's industrial base was developed in the early 20th century and preceeds much of China. It is the site of the well-known steel works in Anshan and coal mine in Fushun. Its foremost contribution is in heavy industry (output value RMB 437 billion in 1986) ranking it first among all provinces in heavy industrial output. It also ranks first in power generation, iron ore reserves and iron and steel production. Total industrial output was RMB 66,439 billion ranking it third in China after Jiangsu province and Shanghai metropolis.

B. Environment. Much of the urban environment in Liaoning province's highly industrialized cities is marked by severe pollution of air, earth and water. Episedoes of health-threatening levels of air pollution occur frequently; surface waters contaminated by industrial wastes pollute ground water which is used as a sources of drinking water; and crops irrigated with industrial waste water because of water scarcity have become contaminiated by toxics and rendered inedible.

C. Water environment. Liaoning province is situated between 39 and 43 deg.N latitude and between 119 and 126 deg.E longitude. It has a temperate continental monsoonal climate with a hot rainy summer; a long cold winter with little snow and a short windy spring. There are only 130-180 frostfree days. The average annual precipitation is 400-1000 mm decreasing markedly from southeast to northwest.
There are 16 rivers with over 1000 sq.km. catchment among the total 221 rivers in Liaoning province. There are 19 reservoirs which have capacity over 0.1 billion cub. m.
Although there are plenty of rivers and reserviors water resources are still deficient due to the uneven precipitation, high evaporation and the improper control measures. Annual water resources per capita is 987 cubic meters which is much lower than the national standard.

(See Table 3)

The table shows the worst center area with shortage of water supply and heavy pollution.

(See Table 4)

The Hunhe-Taizi river basin, running southwest through the heartland of Liaoning province is the focus of water resource concerns because of it's urban, industrial and agriculture pre-emince in the province. It has located in or near it some of China's largest heavy industries and major sources of coal and iron ore and economically important cities of

Anshan, Benxi, Fushun, Liaoyang, Shenyang and Yingkou. The cities have a combined population of 9.7 million and account for about 58% of Liaoning's industrial output. However the surface water can't meet the need of rapid development of urban water demand which had been increased 10 times since 1949 to 1985.

Most of liquid wastes generated in the province are discharged without treatment to the river system through industrial outlets, combined sewers or irrigation channels. So the polluted surface water even ground water can no longer be used.

D. Health impact. The greater part of these wastes containing the toxic and hazard pollutants as oil, phenol, cyanide, benzopyrene, entered the Hunhe and Taizi river basin, most of these wastes reappear in the supply of down stream users.

For example, over 120 sq.km. land and more than 30 drinking water wells are polluted by nitro-compound with concentration of 0.5 - 2.6 mg/l.

300 teenagers (polluted water drinkers over 10 years) were checked and heinz body in their blood were found, even higher than 12%, where as the rate was zero in another non-nitrocompound area (Shenyang).

The death rate of malignant tumour of the residents drinking the polluted water for longer period is 110.62 per 0.1 million, but only 72.26 per 0.1 million in areas with safe water, a 52% higher incidence rate.

The river water is heavily polluted by domestic wastes containing E-coli 4650/l; total bacterium 0.15 billion/l; chloride 500-1375 mg/l. The incidence of dysentery is 502.56/0.1 billion, typhoid fever, paratyphoid 2.51/0.1 billion, virus hepatitis 86.96/0.1 billion respectively among the residents drinking the polluted river water.

Shen-fu district farmland is irrigated by untreated waste waters from refinery plants which result oil content 338-410/100g soil and benzopyrene 226.5-500mg/100g soil. Oil content in water is 0.33-0.48mg/l, phenol 0.0042-0.005mg/l, benzopyrene (Bap) 0.025-0.08 ppb. Bap content in rice reaches 0.16-1.44ppb. The death rate of stomach cancer is 45/0.1 billion persons, but only 12/0.1 billion in another comparable but less contaminated district. Malformation foetus rate is 3.06/1000 and congenitial malformation reaches 8.28/1000 which is 2-3 times higher than the other districts.

Fluoride content in some ground water is over 16mg/l which poisons 0.43 million of residents, among them 0.396 million are suffering from yellow stains on the teeth and 3000 from bone fluorisis. The total patients of above mentioned diseases are 31,000.

III. Control measures

A. Cofinanced urban study. With the Chinese governmental approval, and Australian-funded Urban Renewal Study is being carried on in Liaoning Province at the present period.

On the water issue the study objects are as follows:

(a) To prepare a strategy for the development, allocation, use and management of the water resources of the central area of Liaoning Province (catchment of Hun-he and Taizi) and the treatment (industrial, municipal) of used water and its return to the environment. The strategy must seek to resolve existing or potential conflicts for water use (agriculture, domestic and industrial) and the attainment of an improved water quality environment.

(b) To decide on technically and financially feasible water quality goals (river, estuary and marine) to be attained step by step over a planned period of time.

(c) To propose (at strategy level) non-physical actions and financial investments for works that are required to best meet the competing interests of the water users and the disposal of liquid waste to the environment.

(d) To propose an action-oriented program for the orderly development of water resources and the return of used water to the environment. The program should address all major issues inlcuding:

(i) industrial waste discharge policy;
(ii) institutional reform;
(iii) regulatory, pricing and policy issues;
(iv) water resources development and allocation;
(v) program of physical works and non-physical action including measures to:
- improved efficiency of use by industry and agriculture
- pre-treatment of industrial waste as appropriate
- establishment of municipal waste water treatment works (including line treatment for agriculture re-use), and oxidation ponds
- development of augmentation of water resoures and reuse of treated water for the augmentation of low season river flows and achievement of water quality goals.

(vi) to identify and evaluate significant projects (e.g. water supply, river control, flow augmentation or waste water treatment) that are essential to the overall strategy, so that they may proceed to independent feasibility studies, financial approval, funding and design construction decision prior to finalization of total strategy.

Additional reserviors and possibly water transfer schemes, combined with improvements in the efficiency of water use and a reallocation among users, will be required to maintain adequate waste assimilation capacity of the river system. The basin, the water user and the waste producers would be viewed as parts of a common system, and plan construction and non-construction measures in a comprehensive integrated and basin wide way so water supply and water quality objectives can be achieved at least cost.

B. Regulations and Laws. The Environmental Protection Bureau of Liaoning Province (EPB) has prime responsibility for controlling liquid wastes to rivers and irrigation areas. National standards for licensing discharges were issued in 1973 and new national laws were promulgated in 1983. Essentially the system acts as a pollution "tax" and industries have the option of investing in treatment facilities or paying the tax.

At the national level the following policy measures are emerging to promote conservation and reduce pollution:

(a) Increase the water resources tax payable by industry.

(b) Impose quotas on industrial consumption based on production and technology type, and tax quota exceedance.

(c) Regulate to force water reuse.

(d) Strengthen "pollutions pays" policy measures.

(e) Devote more attention to non-point pollutant sources.

(f) Employ rational policy for promoting treatment: require pretreatment for selected pollutants but in general require municipalities to build regional treatment facilities.

(g) Finance for capital works will come from national or provincial governments but municipalities will pay for operation and maintenance.

(h) Sewer department will be self-financing and will apply tariffs accordingly.

C. The way ahead. We have focussed on Liaoning's growth prospects and the concommitant need for water supply and drainage. Liaoning's industry will be a key element in China's modernization and export drive. Economic and urban population growth is expected to exceed the national average and will occur in the central area of the province. We will have to catch up in the provision of urban service, especially water supply. Recognising the need of sizable investments the National Government has agreed to more equitable cost sharing arrangements than in the past. Liaoning and it's municipalities will better mobilize financial resource through taxation, borrowing and increased reliance on user fees.

Map of Administrative Districts of Liaoning Province in China

TABLE 1

SURFACE WATER DISTRIBUTION

COUNTRY	WORLD	USSR	JAPAN	CHINA	LIAONING
surface water (m^3) / capita	12,700	18,900	4,796	2,700	987

TABLE 2

AREA / POPULATION	TIANJIN (M)	LIAONING (P)	BEIJING (M)	SHANGHAI (M)	JIANGSU (P)	GUANGDONG (P)	TIBET (A)	XINJIANG (A)
TOTAL (millions)	8.08	36.86	9.60	12.17	62.13	62.53	1.99	13.61
URBAN	5.65	24.82	6.40	7.49	15.96	180.77	0.21	5.85
URBAN PERCENTAGE %	69.9	67.3	66.7	61.5	25.7	30	10.6	4.3
RANK (URBAN %)	1	2	3	4	24	20	29	9

NOTE: M=Metropolitian P=Province A=Autonomy region

TABLE 3

WATER RESOURCE DISTRIBUTION IN LIAONING

	EAST	SOUTH	WEST	CENTER	
GROUND WATER	0.149	0.371	1.490	5.454	BM^3
	2%	4.97%	19.96%	73.07%	%
SURFACE WATER	12	5.835	4.467	11.2	BM^3
	35.82	17.41	13.33	33.43	%

TABLE 4

URBAN INDUSTRY/DOMESTIC WATER COMSUMPTION IN LIAONING

TOTAL	EAST	SOUTH	WEST			CENTRE							
	DAN DONG	DA LIAN	JIN IHOU	FU XIN	CHAO YANG	SHEN YANG	FU SHUN	AN SHAN	LIAN YANG	BEN XI	YING KOU	TIE LING	OTHER
776.3	34	37.3	27.4	17.1	3.9	131.3	104.9	107.5	64.4	98.7	19.3	25.7	

SESSION V
HOUSING, ROADS AND OTHER SERVICES

Chairman: Amran Hamzah
Department of Town & Country Planning
Faculty of Architecture
Universiti Teknologi Malaysia

PAPERS PRESENTED

Professor N K UPADHYAYA and Mrs P UPADHYAYA
Disposal and utilization of steel plant waste

C KARIYAWASAM
Disposal of excreta and sullage

MOHD WARID HUSSIN and KAMSIAH MOHD ISMAIL
Polypropylene reinforced cement sheets

Dr J C SRIVASTAVA
Technologies of women's low-income housing needs

MEGAT JOHARI MEGAT MOHD NOOR and AZLAN ABDUL AZIZ
Soil-cement for low cost roads

Dr R M BRADLEY
Squatter area upgrading in Malaysia

A G WRAY
Urban project development trends - Philippines

Dr ANDREW COTTON and RICHARD FRANCEYS
Services for urban low income housing

Professor CHE XIANXIN and BAI YONGJIU
Liaoning water pollution and control measures

DISCUSSION

Professor N K UPADHYAYA

1. Mr LANE asked if the waste materials described in the paper were sorted by hand and if so what were the health effects of exposure to large quantities of such materials.

2. Professor UPADHYAY said the materials were sorted by hand. There was a positive health hazard in doing so due to dust pollution from which health related problems could develop.

C KARIYAWASAM

1. Dr BRADLEY commented that the low priority of improved excreta disposal facilities was also found in squatter areas in Kuala Lumpur where only 5% of those surveyed considered it an essential upgrading measure. In all ongoing USAID projects in Sri Lanka community participation in the selection of sanitation facilities was based on organizing the community to elect family health volunteers (each representing ten to fifteen families). The volunteers first received health education and then educated the community in sanitation/health linkages etc. This process took about one year. After this the community chose which type of upgraded excreta disposal system it would prefer and could afford.

2. Mr GHOSH asked Mr KARIYAWASAM what he meant by community participation and suggested he meant health education. He also wished to know which was the target group for communication; was it women or adult males? Was there any connection between habits/attitudes and economic growth? What were the toilet designs in rural areas?

3. Mr KOLSKY commented that the author had noted that 80% of the possessors of flush toilets did not use them. He asked if they had installed them themselves or if they were already installed before they came into possession of the home.

4. Mr KARIYAWASAM said that the flush toilets had been installed by the owners of the homes as they were considered to be a status symbol.

Mr AZLAN ABDUL AZIZ

1. Mr KOO HOCK SONG asked how cement and laterite were mixed in the field and could this method be used in hilly regions.

2. Mr AZLAN explained that cement and laterite were mixed by ploughing the surface and raking in the cement powder. Difficulties had not been experienced wherever a tractor could operate.

3. Mr LANE commented that it might be interesting to try reducing the cement percentage and increasing the rice husk ash content instead, as the latter was cheap and widely available.

4. Mr AZLAN said the initial study was to look at the effects of additional additives, ie sand and RHA, on the soil-cement mix. The present investigation looked at a reduction in the cement percentage and an increase in the RHA.

5. Mr NICHOL wished to know the details of size/length of the field trial plot, the duration of the trial and any loading/trafficking of the surface.

6. Mr AZLAN said that the objective of the trial plot was to study the affect of the weather (ie rainfall and temperature) on the performance of unpaved, stabilised, low-cost roads and also to assess the ease of construction. There was no loading/ trafficking applied. The duration of the trial was one year. The width of the trial plot was 4 metres and the length was 12 metres.

Paper No 3 Session 5
Squatter area upgrading in Malaysia

In introducing his paper, Dr Bradley summarised the main findings of the field surveys and emphasised that the upgrading recommendations relating to water supply and excreta disposal were applicable only to the priority areas affecting about 10% of the squatter population. He confirmed that the survey found no evidence of nightsoil buckets being used in squatter areas, this system was in use in legal housing areas.

Dr Bradley presented additional data on parasitic infestation rates from field surveys conducted in Kuala Lumpur in 1982. The results showed that families who used water for anal cleaning and tended to eat food with their fingers had an infestation rate of 38% in sewered areas and 62% in non-sewered areas. Rates in the same areas for families who did not adopt these practices were 19% in sewered areas and 41% in non-sewered areas. These results illustrated the importance of health education and hygiene practices in upgrading the health status of the community.

Dr Bradley concluded his presentation with the latest data (December 1987) for squatter population and nightsoil buckets. The current situation was that the squatter population had now fallen to 145 000, an annual average decrease of about 9% since the end of 1984. This decrease illustrated the success of the mainly privatised squatter area upgrading programme. Nightsoil buckets had also been reduced to about 2000 from 5400 at the end of 1984. Of the 3400 buckets which had been converted in the last three years, about 35% had been converted to sewerage and the remainder to septic tanks or pour-flush latrines.

Dr ANDREW COTTON

1. Dr BRADLEY wished to know the loan terms of ODA to the Government of Sri Lanka and of the Galle Municipal Council to the community.

2. Dr COTTON explained the the loan was made from the ODA to the National Housing Development Authority of Sri Lanka who on-lent to the Galle Municipal Council. The project was in its infancy, but the Galle Municipal Council proposed to look at the repayment of housing loans as an indicator of a particular community's "credit worthiness".

3. Dr BRADLEY asked how many families had asked for additional water and sanitation facilities and what were the most popular improvement requests (roads, power etc).

4. Dr COTTON said that the main concern of occupants of the sites which were to be upgraded was for regularization of the plots and sorting out disputed ownership. There was little indication at present of strong priorities for improved service levels such as a house connected water supply. All householders on site and services schemes were required to take out a loan for a household pour-flush latrine.

5. Mr COFFEY commented that concrete pipe was proposed for small septic tanks. Two 1 metre diameter, 1 metre long pipes on a concrete base with a concrete cover and outlet T-piece would cost M$300. This would represent 30% of the total pour-flush latrine cost (single pit) using raised soakaway mounds, or 15% of the total cost if a seepage pit was used.

6. Mr KARYAWASAM said that private sector organizations were not interested in community participation as it would have no economic benefits. How was it proposed to hand over the development work to the private sector and obtain community participation simultaneously.

7. Dr COTTON explained that community participation did not necessarily imply that the community did the actual construction work itself. The important issue was that the community had control over its destiny; this could be achieved by the community paying a private contractor to undertake work, or by forming their own contracting system.

8. Mr PIGGOTT asked Dr COTTON to elaborate on the success of pit latrines in the densely populated housing areas in which they were being installed. Did he have any operating/performance data.

9. Dr COTTON replied that there was some evidence of pour-flush pit latrines being used in urban areas where the groundwater table was high, and that the rate of sludge accumulation might be quite low. The Sulabh

International Organization in India had achieved great success in the installation of such latrines in very densely populated areas, such as Patna.

Mr BAI YONGJIU

1. Mr LANE wished to know how the money was raised to pay for the anti-pollution measures described in the paper.

2. Mr BAI YONG JIU explained that the general principal was that the polluters paid. Finance was also arranged by the government on different levels (the Environmental Protection Bureau acting as agents) and from industry.

3. Mr COFFEY asked if all the areas in the cities were served by sewers and if not what systems were used in the unsewered areas.

4. Mr BAI YONG JIU replied that sewers were available in all cities but not in rural areas. In these areas excreta was collected by individual householders and used directly to fertilize farmland.

14th WEDC Conference

Water and urban services in Asia and the Pacific

Kuala Lumpur 1988

DISCUSSION GROUP REPORT
Analysis of water and wastes

Chairman: L G Hutton
Rapporteur: Er Ranlan Abd Aziz

A small group of participants introduced themselves and some expressed a need for information on methods and quality parameters. The WHO Guidelines on Drinking Water Quality were described and the GEMS Operational Manual were felt to be relevant to many countries. The 15th Edition of APHA/AWWA/WPCF was felt to be too complicated and instrumentally biased. Manual methods of water and wastewater were more useful and appropriate for many parameters.

During the Conference it was felt that more emphasis should have been placed on the relationship between health, disease and bacteriological pollution. The use of feacal coliform and total coliform organisms, faecal streptococci and plate counts for total bacteria to detect and count faecal contamination was discussed. Delegates called for more rapid methods of bacteriological analysis and current research was described.

For treated water the use of chlorine detection was recommended to indicate the absence of bacteria. DPD was described and one or two participants indicated that they still used o-tolidine. After the session they said they would switch to DPD soon.

BOD was considered to be too long, tedious and not relevant to local conditions where water temperatures were much higher than 20°C and toxic materials interfere. COD by the micro tube method was more relevant and similarly the 10 minutes Permanganate Index was felt to be useful information.

Oil and grease in wastewater analysis was best detected visually.

The use of the Biotic Index using the benthic life of rivers and streams was felt to be very appropriate for use in developing countries. Researchers at Malaysian universities were encouraged to investigate Biotic Indicators to detect pollution. Fish monitors had been used at some waterworks in Malaysia.

The concepts of on site and field testing were well received.

The discussion was terminated with many topics covered and delegates' questions answered satisfactorily. The contributions by the delegates from China were particularly well received.

Highlights of discussion

1. Bacteriological
   - major parameter in developing countries for drinking water quality is bacteriological;
   - many childhood deaths are due to dehydration arising from diarrhoea; although cures and treatment are simple more education is needed on the treatment required for dehydration; however, stress should be put on prevention, for example providing safe drinking water and sanitation;
   - attention should also be given to the possibility of pollution in water distribution systems, especially in an intermittent supply; treatment of water at the plant is easily controllable compared to pollution in distribution systems

2. Chlorine detection
   - DPD tablets: cheap, non-toxic, easily available, easy to handle and long life (10 years)
   - starch and potassium lodide are suitable for rural areas with no DPD

- ortho-tolidine is not recommended as it is found to be carcinogenic

3. Coliform bacterial
Good indicator for recent faecal pollution, therefore the possibility of pathogen present.

4. Virus
Viruses are difficult to detect. They are very highly resistant, even to boiling, and have a low infective dose. More research is needed.

5. Physical analysis
pH is more important for treatment than for health.
Water cannot be purified with chlorination if highly turbid.
Suspended solids provide sites for bacteria to breed and survive.

6. Wastewater analysis
- dissolved oxygen is a very important parameter life giving; the higher the temperature the lower the DO, therefore more critical in warmer parts of the world
- good test for water quality - primary parameter

BOD
- based on the English River Severn at 20°C (5 days travelling time from the source to the seas)
- not really relevant to other countries as a parameter, especially in warmer climates
- if toxic material is found, BOD parameter is quite insignificant

COD - recommended the cheaper, smaller and safer form of analysis, using water; it requires only a small space and sixteen samples can be tested at one time.

Oil and grease - visually objectionable and detectable. Decreases the amount of O_2 transfer. Check of source upstream. Sophisticated equipment only gives a value but does not stop pollution.

Biotic index (river quality) - should be used more as an indicator of pollution. It is very cheap and less apparatus is needed. Personnel are easily trained. There is a need for systems to be developed for tropical countries. This offers good scope for research.

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Water and urban services in Asia and the Pacific

Kuala Lumpur 1988

DISCUSSION GROUP REPORT
Community participation

Chairman: Dr Morag Bell
Rapporteur: Cik Hasimah Alias
Discussion note: Jon Lane

The discussion in this session could be summarized into four main points.

1. The choice of services, whether water supply, roads, sanitation or others should be left to the community. It is the community who should decide on their priority.

2. The professionals from outside the community should provide technical advice and support. Above all they should supply a well-functioning system for the users.

3. Maintenance could be a problem but if the community is involved in the construction their technical interest would develop which would make the maintenance easier. The person to take the responsibility should be chosen by the community at the construction stage and trained at that time.

4. Education, including health education, is vital for any successful community participation and progressive development.

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Latrine Choice in Peri-urban Nepal

Jon Lane, WaterAid, Nepal

Introduction.

My aim in this note is to stimulate discussion and request views and advice from fellow participants on the subject of the choice of latrine types. The context for the discussion is the periurban area of Nepal, particularly the Kathmandu Valley. This is an agricultural area in which the villages and towns are small in area, densely populated and long-established.

Various organisations are conducting sanitation projects in this area, and to a varying degree involve the people of the community in the choice of latrine type and technology. This note sets out some ideas and questions about latrine choice, attempting to view the problem from the point of view of the community members. I believe that only by doing so from the beginning can a project contribute successfully to the welfare of that community.

Cost

My assumption here is that the latrines are intended to be at least partly financed by the beneficiaries themselves. Therefore cost is likely to be the major factor influencing the choice of latrine design and materials. The agriculturalists of this area have very little cash at their disposal. They also have limited time available, and may have many other activities which also make demands on their time and money. Construction of a latrine needs to be a high enough priority when compared with, for example, improving field terracing, keeping more livestock or buying school books and clothes. Educational and promotional work is important for raising the priority of latrines. Project staff need to find out how much money people wish to spend on latrines.

Are different designs available for people of different income levels, particularly where latrines are viewed as status objects? In all cases the designs available should be costed sensibly for that area. (A Zimbabwean VIP Latrine, for example, would be extremely expensive by Nepali standards). Are the materials which the project staff have in mind actually available at reasonable prices in the locality?

Acceptability and Convenience

Social and cultural restrictions play an important part in decision-making related to sanitation. Can all the members of the family use the same facilities? Is it even acceptable to defaecate regularly in the same place?

Some may prefer the convenience of a latrine inside the house, with pits outside (which immediately leads to an offset design, usually needing water for the transport of faeces). Others may not wish to site the latrine indoors, as was the case in Britain until only a few years ago. Privacy for adults may not be compatible with children's fear of dark places so the children may continue to defaecate in the street instead of in the latrine.

Waterseal latrines are generally advocated because they reduce smells and flies: but many people have never had the chance to learn that flies transport diseases, and may not be bothered by smells when sharing their houses with cattle, pigs and other animals. They might opt for a cheap easy pit latrine instead.

Buildability

Few people can afford to employ professional craftsmen, so the latrine design needs to be easily understood and built. Pit covers and sloping channels or pipes are often unfamiliar objects- how can they be made relatively foolproof in design? The materials need to be both available and familiar. Taking pit linings as an example, in the Kathmandu valley brick is predominant but expensive for this purpose. Bamboo soaked in old engine oil is cheap, but how durable is it and will people reconstruct such linings in a dirty, used pit? Dry stone masonry may be cheaper than brick but is cumbersome to use in congested urban sites. Precast concrete rings require a large area on site to manufacture. Nobody who is buying a latrine component, however cheap, is satisfied if it breaks. Durability is important, but how can it be made compatible with economy?

Maintenance

Many people are utterly unaware of maintenance requirements or indeed of the concept itself. Ease of maintenance is inherent in the latrine design : is the pan shape and surface easily cleanable, is the floor material smooth and impermeable, is there enough light to see to clean the latrine? There is even an argument that waterseal latrines should not be built because people do not flush them with enough water so the waterseal becomes a faeces- or urineseal instead: even a shallow pit nay be preferable to this.

The emptying of decomposed pit contents presents another problem. How will people know when the pit is safe to dig out? Who will be prepared to handle human faeces even when decomposed? Where should the contents be put if the owners have no fields of their own? Some people may wish to encounter these problems less frequently simply by making bigger pits in the beginning.

Public Latrines

Some people do not have the money or land to build their own latrines. Should they be encouraged to club together to build group latrines? Should public latrines be built instead, and if so, by whom? Should these be designed for privacy or for ease of cleaning? Most important, who will manage the cleaning and maintenance and how will this be financed? Sometimes the users themselves may clean the latrines or they may all contribute to the salary of a cleaner. It may even be possible to run public latrines on a commercial basis by making a compulsory or voluntary charge for their use to cover running costs. I feel that this last point is one of the most interesting for project staff to discuss and investigate.

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DISCUSSION GROUP REPORT
Finance, administration and human resource development

Chairman: Alistair Wray
Rapporteur: Mohd Zahry Othman

The discussion that took place in this relatively small group was fairly free ranging reflecting the broad scope of the discussion topic and the interests of the members.

The degree of involvement of aid agencies in development programmes was reviewed, ranging from a purely training function to the provision of building loans or precast units to complete construction. Training activities and public relations work can be very cost effective. An example was cited of literacy classes in Nepal using a latrine programme as teaching material which developed a demand for implementation of the latrine programme in the area. A solid waste management programme in Trinidad was complemented by a very effective anti-litter campaign using cartoons which created a popular image. Avoidance of ambiguity in training material is essential. The insistence of Timorese on boiling water which had been collected off roofs illustrated this point. The involvement of agencies in manufacturing pre-cast units, with reference to latrine slabs, pit rings and septic tank units, was discussed. Pre-casting allowed improved quality control and could produce materials savings, the possibility of employment generation and a self-sustaining programme. Precast products were generally readily accepted by the local community but it was important that designs were consistent and free from apparent defects. Involvement of the community in the installation work was most important.

The importance of training in developing an appreciation of the benefits of a scheme and instilling a willingness to pay for a facility and hence recover costs was noted. The difficulties in recovering costs in sanitation programmes were considered.

Success was reported in linking a public latrine facility to an enterprise such as a workshop, where the profits could be used for latrine operations and maintenance. A similar scheme in Nepal associated a public latrine with a shop, and in return for this facility the shop was responsible for operations and maintenance. In Manila, local residents had to register for the use of public toilet facilities and the use of a laundry washing area and pay fees which covered the cost of water, operations and maintenance. However, none of these examples attempted to recover capital outlays. It was noted that some agencies attempt to cover costs by requesting the beneficiary organisation to provide a comparable amount of labour to work on similar projects to offset against earlier capital costs rather than insist on full recovery.

As part of the discussion on human resource development and project administration, the value of sociologists and anthropologists as members of a project team was mentioned. Urban upgrading, water supply and sanitation schemes were cited where this was particularly beneficial. Time spent in talking to the local people, involving them in the building work and in developing strong links between the community and the project was very useful, a point not often appreciated by head office organisations. Such arrangements also facilitated feedback from the people using facilities or equipment which enabled subsequent improvements to be made.

The use of experts on short visits to a project was discussed, particularly their role as a catalyst where a detached view of a project can be taken and a range of ideas generated. However, it was noted that this must be balanced by workers with strong local experience able to weigh up these ideas and filter them. Too often a visiting expert's points are taken unquestioningly. Training can assist in developing capabilities to review suggestions and inputs objectively. It was generally felt that there were many areas where more ideas could be borrowed from the commercial sector.

The problems apparent in trying to measure the success of projects were discussed. Bankers' criteria such as speed of disbursement or aid agency's targets such as the number of facilities installed often did not reflect whether a project had been a success or failure, or whether it met its original objectives. Often speed of implementation was taken as an indicator of success and money spent in turn released more money for

projects, regardless of true project performance. This emphasis on speed could be in conflict with proper training requirements and community involvement in implementation. It was also noted that project implementation work was often tailored around the need to consume a budget allocation within a particular time frame and could lead to a somewhat irrational approach.

The conditions attached to loans and grants were debated. It was noted that equipment life was invariably far shorter than the loan terms and provisions for equipment replacement funds were essential if ever increasing debt repayment problems were to be avoided. Often local accounting procedures made proper provision of funds for these purposes difficult. Finally, it was noted that the value of aid to the developing world from developed countries compared to the value of trade was extremely small, and if viewed in terms of a discount on the trade value, should be greatly increased.

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Kuala Lumpur 1988

DISCUSSION GROUP REPORT
Integrated urban development

Chairman: Alistair Wray
Rapporteur: Rosman Rais
Discussion note: Zakariya Abdullah and Ahmad Ainuddin Nuruddin

Zakariya Abdullah presented a discussion note on Urban tree planting in relation to other urban services. The emphasis on tree planting in urban areas in Malaysia since the early 1970s was discussed together with some other problems which had become apparent, for example the choice of fast growing trees presenting maintenance problems such as pruning and rapid root development disturbing services and buildings.

Growing trees could cause major problems such as growing hair roots damaging sewage pipe joints, lifting foundations and floor slabs and obstructing road junctions. There was a clear need for policies relating to the selection of species. Guidelines for suitable locations for planting were necessary along with further studies of root development.

The group went on to discuss landscaping and space allocation in low-cost housing. Planning guidelines relating to minimum plot size and setbacks for low cost housing schemes were considered together with the scope for future expansion.

Because of the size and the transportation pattern of Kuala Lumpur the proposed Mass-Rapid-Transit system was considered to be inappropriate. Emphasis should be placed on a public transport scheme and selective management measures. It was noted that previous schemes for restricting private vehicles during peak hours had, for various reasons, not been implemented.

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URBAN TREE PLANTING IN RELATION TO OTHER URBAN SERVICES

Zakariya Abdullah and Ahmad Ainuddin Nuruddin

Introduction

Asian cities are fast expanding with high population growth. Problems of housing, water supply, sanitation and other services are common. Kuala Lumpur, like any other growing Asian cities, is facing similar problems. However, effort has been taken to improve its urban living conditions. Apart from provision of adequate housing, water, sanitation and other basic necessities, there are programmes to improve the urban environment through proper city planning. To provide comfort and beauty to the city, trees are planted along its roads, streets and open spaces. Trees are important because of the services they render to the urban environment as summarised below:

Environmental function	- filtering of dust particles, pollutants and provision of oxygen and improving microclimate
Engineering functions	- noise reduction, erosion control and reduction of glare
Architectural functions	- blending of trees and buildings for beauty and functions
Aesthetics	- beautification of urban environment, landscaping and screening of unwanted sights
Socio-economics	- development of parks and recreation areas and promotion of economic activities through tree planting

Generally Kuala Lumpur can be regarded as a green city. Its tree planting programme took a full swing within the last ten years headed by the Dewan Bandaraya, Kuala Lumpur with support from both public and private organizations, including individuals and homeowners. Furthermore, it is by law that developers are to plant trees in the newly developed housing estates.

Problems to Tree Planting and Services

Urban tree planting is associated with problems of species selection, soil compaction, water stress and damages due to construction and vandalism. In addition, competition for space with other urban services such as telephone and transmission lines, water pipes, drains and sewerage is on the rise. Competition for space may occur either aerially, on the ground or below ground.

Problems are two ways, depending on which comes first. If installation of any of the services is done in an area already planted with trees, then trees are at the receiving end. On the contrary, if trees are planted in an area where utilities have been installed then damage could be caused by trees.

The damage can be snapping of branches, breakage of crowns, stem or root injury or even mortality, depending on the severity of the disturbance. Trees may interfere or snap off transmission lines or may cause breakage of pipe and drains or road shoulders by massive root penetration. Windfall may severely disrupt various urban services such as electric service and traffic movement.

Causes of Damage to Trees

Road and home construction
- actual severing of portions of root system
- indirect killing of roots by (a) compaction of solid surface, especially by heavy equipment, (b) fill over existing surfaces from road construction or (c) impediment of drainage so that flooding or a raised water table results, usually in swamps or poorly drained soils
- indirect damage by reducing amounts of soil
- damage to holes by heavy equipment
- sunscald wounds on thin-bark trees after exposure of previously shaded boles

Roads and grade outs
- causes a more serious loss of soil moisture to nearby trees

Fills
- damage to trees is caused by deposition new soil on top of the previous soil surface through grading, filling or sedimentation

Suggested Solutions

1. Coordinated planning between various departments for installation of services and tree planting and removal.
2. If trees are to be planted in an already existing utility and service site, care should be taken to ensure that:
   i. species chosen should not develop height, crown size and root system that may interfere with any of the utilities;
   ii. trees are not susceptible to ailments or characteristics that are prone to wind damages.
3. When installing utilities or services ensure that:
   i. construction work will not result in damages directly or indirectly to trees;
   ii. diversion is made within acceptable range to avoid contact with trees or any of their parts.
4. Provide guidelines to tree planting and services installation to avoid current and future interference or damages to one another. Supervision of tree planting or services installation by knowledgeable personnel.
5. Good inventory of trees in the city. Able to know the condition of trees.
6. Early treatment of damaged trees. Practices such as pruning, watering, aeration, mulching, fertilization and pesticide spraying are effective in saving damaged trees.

Further Reading

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Water and urban services in Asia and the Pacific

Kuala Lumpur 1988

DISCUSSION GROUP REPORT
Low-cost building

Chairman: Richard Franceys
Rapporteur: En Azhar Ahmad

The majority of the group were Malaysians so no real dicussion could be held because the Malaysian Government faced rather different problems than usually experienced in other developing countries. Their understanding of low-cost building differed in that their problems were concerned with typical commercial management to lower the cost. The material was cheap because it was subsidised, for example the cost of cement was M$4 for 50 kg and timber was plentiful. However, labour costs were very expensive. This was completely opposite to most developing countries where cement was expensive and labour costs were cheap.

Malaysia is a developed nation in terms of housing and construction, and in facing labour problems. Many of the workers came from Indonesia, some illegally. However, since the construction boom was slowing down, the illegal workers were facing and creating social problems similar to the problems existing in Europe.

Participants from other countries such as Nepal, Bangladesh and Sri Lanka, had difficulty in discussing their problems with the Malaysians because they were so different.

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Kuala Lumpur 1988

DISCUSSION GROUP REPORT
Low-cost sanitation

Chairman: Richard Franceys
Rapporteur: Mohd Asri Md Nor

A wide ranging discussion fully utilised the session allotted to the consideration of low-cost sanitation. Participants with a variety of backgrounds and experience looked systematically at the different types of sanitation appropriate in different cultures. They also considered rates of sludge build-up and longevity of pits, need for pit linings, pollution travel, construction of components for slabs, seals, seats, vent pipes and superstructures. Following the formal presentation by Mr Manus Coffey, particular attention was paid to methods of pit emptying.

It was generally considered that many people learned some new ideas and had old ideas about low-cost sanitation usefully reinforced as a result of the discussion. To have over a dozen countries represented led to a stimulating and fruitful dialogue. However, at the conclusion the participants wanted to repeat to the main body of the Conference the vital necessity of designing low-cost sanitation systems that were culturally acceptable, technically feasible and above all were affordable, whether by user or sponsoring agency, individually or in partnership, throughout the entire lifecycle of the system.

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Water and urban services
In Asia and the Pacific

Kuala Lumpur 1988

DISCUSSION GROUP REPORT
Sewerage

Chairman: Geoffrey Piggot
Rapporteur: Kamarul Azlan

A total of nine participants attended the discussion group. Most of the participants came from Malaysia, from Sewerage Authorities, Municipal Boards, Housing Development Corporations and Consultants. A range of topics was discussed, mainly concerned with Malaysian experience.

It was agreed that conventional sewerage could be an appropriate technology, particularly in areas which are densely populated. In Malaysia, as in many other south-east Asian and Pacific countries, there were severe restrictions on funds for the provision, operation and maintenance of sewerage schemes. This was forcing engineers and administrators to seek lower cost sewage system components. Engineers inherent conservation in design often hindered the realistic consideration of other options, for example pipe materials.

Other forms of "non conventional" sewerage were identified and it was agreed that these systems should be considered particularly where existing on-site systems were being upgraded to a piped system. These systems included variable grade sewers, septic tank effluent pumping systems, grinder pumping systems and vacuum sewers. Standardisation of design procedures was needed where different cities and states each had their own standards. This included the need to standardise design flows, bedding methods etc.

The group discussed the problem of septic tanks in south east Asia; in particular the problem of direct connection of tanks to waterways and drains which involved risks to public health. It was generally agreed that efforts should be made to examine soil permeability and where possible to utilise soil absorption systems. The poor performance of some septic tank systems was recognised as having resulted from the lack of regular desludging. In Malaysia, as in many other countries, septic tanks were usually desludged upon request only. This normally occured when the sludge/scum had built up to a level which would cause blockages in the tank and associated pipework, thereby causing offensive overflows. It was agreed that efforts should be made to develop programmes of regular desludging of septic tanks although it was recognised that current funding constraints would make it difficult.

The design of small sewage pumping stations was discussed and it was generally agreed that for design flows less of than about 50 l/s submersible pumping stations were the most cost effective and least maintenance option. The problem of low flows in the early stages of a scheme was discussed and the difficulties the designer had in sizing the wet well and determining the pump size and switching arrangements.

Operational experience with stabilisation ponds was provided by the participants. The presence of algae in the effluent was recognised as a problem in some cases. It was difficult to meet effluent suspended solids standards because of algae and this should be recognised by relevant government agencies when setting effluent standards. Filtered effluent BOD_5 and SS levels should be specified where possible. The problem of the accumulation rate of agal/scum/duckweed on stabilisation ponds was discussed and it was agreed that there was no simple answer to this except that it was crucial to remove the material regularly and not to let it build up. Floating booms made from bamboo had been used successfully in Malaysia to collect the material into a corner for skimming off. Disposal by burial seemed to be the most popular method. The possibility of utilising reed bed systems to upgrade stabilisation pond systems was discussed.

Participants described problems experienced in encouraging householders to connect to the sewerage system where provided. In Malaysia, legislation exists to force householders to connect; however, it was usually not enforced. Financial systems to encourage connection were described. These included a discounting system for connections made at an early date and the raising of septic tank emptying charges for those householders who refused to connect and continued to utilise their septic tanks.

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DISCUSSION GROUP REPORT
Solid waste management

Chairman: Dr Andrew Cotton
Rapporteur: Tuan Hj Fadil Othman

This session was introduced by Mr Mustafa Kamal who described the solid waste collection problems in Taiping, Malaysia. Another local delegate, Mr Koo Hock Song from Penang, contrasted this with his own experience, with particular emphasis on the problems and benefit of privatization.

This particular theme proved to be one of the most fruitful of the session. There was a wide ranging exchange of views and experience on the optimum methods of providing a satisfactory level of service in urban areas. It was concluded that the extremes of total privatization on the one hand and the use of only direct labour forces on the other hand were unlikely to be successful in meeting the technical and financial targets of a good solid waste management service. Rather the optimum lay in selecting which method was most appropriate to different areas of a city, and in having the freedom to evaluate tenders on a whole range of criteria rather than just the lowest financial cost.

Other themes explored by the group included the design and manufacture of appropriate vehicles, collection bins and transfer stations, with particular reference to problems associated with low income areas and neighbourhoods where access was restricted. Contributions based on experience from the Philippines, Egypt, Sudan and Sri Lanka, in addition to Malaysia, all ensured that the discussion was lively, varied and absorbing.

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DISCUSSION GROUP REPORT
Wastewater treatment

Chairman: Dr Andrew Cotton
Rapporteur: Mohd Nor Othman
Discussion notes: M Balasubramaniam, N Blakebrough and M A Hashim
K V Ellis and S L Tang

A discussion note by M Balasubramiam, N Blakebrough and M A Hashim was presented by Professor Blakebrough. This led to discussion about colloidal gas aphrons (CGA) being used to separate suspended matter from palm-oil effluent (POME) by flotation. The colloidal gas aphrons are generated by incorporating gas into dilute solutions of detergents. It was shown that 95% of the suspended material could be removed using CGA. This technique could be considered as an alternative to pressurized or vacuum flotation, gravity settling and centrifugation for the clarification of suspensions.

The group then went on to discuss a note by K V Ellis and S L Tang, presented by Mr Tang, concerning the selection of appropriate wastewater treatment technology based on a number of factors such as technical, economic, social, environmental and cultural factors. The twenty parameters listed in the discussion note would be the basis for the selection of the most appropriate treatment alternative. The selection process would utilize a recently developed system analysis technique called eigenvector prioritization and requires the use of a computer program to integrate a 20 x 20 parameter matrix with twenty n x n matrices (where n is the number of treatment alternatives considered). The final ranking of these alternatives is then evaluated from this computer program.

The discussion then turned to waste stabilization ponds and the problems associated with them. One of the solutions to the problem of short-circuiting was to have smaller ponds in series instead of one or two large ones. Water hyacinths and algae were also a problem in ponds as well as the problem of desludging in very deep ponds. The problem of mosquito breeding could be overcome by spraying lime and insecticide and also by breeding fish in the pond.

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Flotation by Colloidal Gas Aphrons

M.Balasubramaniam, N.Blakebrough[+] and M.A.Hashim
Department of Chemical Engineering, University of Malaya
59100 Kuala Lumpur

Colloidal gas aphrons (CGA's) are generated by the incorporation of gas into dilute solutions of detergents. They consist of a dense mass of bubbles, with diameters typically in the range of 25-100μm, and are produced by the use of high-shear devices in the presence of a gas-liquid interface. CGA's show some of the properties of colloidal dispersions. In particular, unlike conventional dispersions of gas in liquid, they have half-lives (the time for half the liquid to separate from the dispersion) of several minutes in the absence of agitation. They remain stable indefinitely when stirred gently. At gas concentrations up to about 65% by volume, aqueous CGA's have viscosities close to that of water, and can be conveyed through pipes using any type of positive displacement pump.

We have used CGA's generated from soap solutions (5.1 gL^{-1} of LUX™ flakes in water at 30°C), to separate suspended matter from palm-oil mill effluent (POME) by flotation in a batchwise operation. Using CGA's with a fractional gas hold-up of 0.65 and suspended solids contents in the effluents of between 2.5 and 15 gL^{-1}, we have removed about 95% of the suspended material. The clarified effluents showed no visible traces of oil. The volume of CGA required was between 7 and 9 % of the volume of liquor clarified. This corresponds to about 2-2.5 % in terms of liquid introduced into the suspension.

In round terms 1 m^3 of soap solution yields 3 m^3 of aphron containing 2 m^3 of gas, whereas 1 m^3 of water saturated with air at a gauge pressure of 5 atm would release only 0.1 m^3 of gas when delivered to a clarifier operating at atmospheric pressure and ambient temperature. The volume of air-saturated water required would, therefore, be about 20 times the volume of soap solution or 7 times the equivalent volume of CGA.

According to Sebba[(1)], the power required to generate such a CGA, using a rotating disc as the shearing device, is 0.15 kWh m^{-3} of entrained gas. The power required to supply gas at 5 atm gauge is about 0.1 kWh m^{-3} [(2)].

+ Present address:- Institute of Advanced Studies, University of Malaya,
59100 Kuala Lumpur

Assuming equal efficiencies of gas utilization in the two cases, it is necessary to offset the difference in power required against the additional capital and maintenance costs involved in providing a compressor and pressure vessel. If compressed air were sparged directly into the flotation vessel, the effectiveness would be less than that associated with the CGA or pressurized saturation, and it is unlikely that there would be any saving in power costs.

The investigations with POME in the batch flotation unit have been extended to a horizontal-flow continuous unit. Experiments have also been conducted with other materials in a vertical-flow continuous unit, and have confirmed the efficacy of CGA's as aids to clarification by flotation. Hydraulic residence times in the continuous-flow units were of the order of ten minutes.

We suggest that this technique should be considered as an alternative to pressurized or vacuum flotation, gravity settling and centrifugation for the clarification of suspensions.

References

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SELECTION OF APPROPRIATE WASTEWATER-TREATMENT TECHNOLOGY

by

K.V. Ellis (Loughborough University of Technology)

and

S.L. Tang (Hong Kong Polytechnic)

The selection of appropriate wastewater treatment technology is based on a number of factors (or parameters) : technical, economic, social, environmental and cultural factors. Twenty of these parameters are identified below:

1. Flow
2. Influent/Effluent
3. Size of site
4. Nature of site
5. Land cost
6. Local money for construction
7. Foreign money for construction
8. Local skill for construction
9. Community support
10. Power source
11. Availability of local material
12. Cost of operation and maintenance
13. Professional skill available for operation and maintenance
14. Local technical skill available for operation and maintenance
15. Administration set-up
16. Training
17. Professional ethics
18. Climate
19. Local water-borne diseases
20. Endemic vector-borne (water-related) diseases

The above 20 parameters will be the basis for the selection of the most appropriate treatment alternative. The selection process will utilize a recently developed system analysis technique called eigenvector prioritization (or analytic hierarchy process) and requires the use of a computer program to integrate a 20 x 20 parameter matrix with twenty n x n matrices (n = number of treatment alternatives considered) for evaluating the final ranking of the alternatives.

Two Case Studies

A. Puchong, Malaysia

The most appropriate treatment alternative was to be selected for a site at Puchong of Malaysia. 8 treatment alternatives were considered:

1. Stabilization ponds
2. Aerated lagoons
3. Biofiltration
4. Activated sludge process
5. Primary settlement
6. Land application
7. Small plants
8. Package activated sludge plants

The computer run gives a result that stabilization ponds (ie. Alternative 1) is the most appropriate treatment alternative for this particular site.

B. South Pattaya, Thailand

This time, 12 treatment alternatives were considered:

1. Stabilization ponds
2. Fully-aerated lagoons + Secondary settlement
3. Fully/Partially aerated lagoons
4. Simple percolating filtration
5. Modified percolating filtration
6. Conventional activated sludge process
7. Deep shaft/High-purity oxygen process
8. Primary settlement
9. Land application
10. Rotating biological contactors
11. Oxidation ditches
12. Package activated sludge plants

The computer run gives a result that rotating biological contactors (ie. Alternative 10) is the most appropriate treatment alternative.

14th WEDC Conference

Water and urban services in Asia and the Pacific

Kuala Lumpur 1988

DISCUSSION GROUP REPORT
Water distribution and leakage

Chairman: L G Hutton
Rapporteur: Abu Bakar Fadhil
Discussion note: John Richardson

A group of sixteen delegates discussed the problems of distribution and leakage. A definition of terms was thought to be useful and delegates found the concept of Non-Revenue Water (NRW) a very good starting point. The discussion note by John Richardson raised many points. The term NRW embraces all water losses. Non-physical losses (theft, meter under-registration and under-billing) can often be of equal magnitude to physical losses (leakage).

Some delegates were unaware of levels of NRW being so high, often 30-50%, even in developed countries. It was felt that greater emphasis needed to be placed on knowledge of distribution design and operations. A supply authority also needed to understand and attempt to quantify the various components of its NRW, in order to direct remedial efforts most effectively.

The use of computer packages for design of distribution systems was to be encouraged. Users had reported favourably. Simple control policies on leakage could be very cost effective. There was a need for more training in distribution system operations, including systematic zonal monitoring of supply and consumption patterns to identify areas with probably high NRW levels.

A discussion on metering supplies covered meter reading, billing, renovation, recalibration and selection of meters. Major problems were lack of supervision of readers, air intrusion in the mains due to intermittent operations, solids in the water clogging filters on the meters, old meters under-reading, recalibration and maintaining a stock of spare parts.

The problems of leakage occurred in old and new systems. Cement mortar relining, air flushing and swabbing had all proved useful in maintaining and renovating systems. Problems in new systems could be reduced by better choice of materials and more control at the site of laying and jointing, particularly for consumer service connections and mains tappings, where most leakage usually occurs.

Mapping and locating the components of the distribution systems was becoming easier with proper record keeping and detection apparatus for finding valve covers, pipes and even leaks. There was still a need for distribution operators to have basic tools, such as a listening stick, valve keys, cover openers and under-pressure tapping equipment.

Leakage and wastage control in consumers' premises was to be encouraged and not to be regarded as a customer problem. Water saving fittings were to be encouraged, especially for consumers billed on a flat rate basis which gives no incentive to control excessive use.

The various costs of water ranged from 35-99 Malaysian cents per cubic metre and better control of water losses would increase the cost-effectiveness of a water supply organisation, and often allow commencement of costly new resource development projects to be postponed.

14th WEDC Conference: Water and Urban Services in Asia and the Pacific

Discussion Note

NON-REVENUE WATER - A LOST CAUSE?

by

John Richardson,1/ BSc, FICE, MIWEM, MIEM

What is NRW?

Non-revenue water (NRW) is defined as that amount of treated and distributed water which does not earn revenue for the supply authority. NRW comprises (1) physical losses - leakage, (2) non-physical losses - authorized free use, theft, meter under-registration and under-billing. Authorities frequently have no idea of the proportions of their NRW attributable to each component and hence no guidance in developing a control strategy.

Is NRW Control Worth Greater Effort?

Almost always - yes. NRW costs money, equal to the marginal cost of its treatment and supply, and if reduced would generate increased revenue immediately in systems with supressed demand (the majority). In urban areas of provincial Thailand, each 10% of NRW saved would immediately generate US$8 million per annum additional revenue from 3.5 million people served.

In developing country urban areas, NRW is typically 30 to 50%. Most systems, struggling to meet demand, have low operating pressures and NRW would be worse with normal pressures. Master plans for expansion often pay lip service to reducing NRW without allowing for the effort and investment needed. Often, NRW actually increases (e.g. Manila, 55% up to 65% when a major supply expansion scheme was commissioned in 1984).

Implementing a formal NRW control policy (systematic leakage detection and repair and improved management practices to reduce non-physical losses) will typically cost US$5-10 per capita. Savings and/or increased revenue will repay this cost within one or two years. Even major rehabilitation, at US$10-30 per capita depending on system condition, will generally cost less than half the price of a new development to provide the same amount of additional water for sale.

Investment to improve performance efficiency of existing assets is highly cost-effective. NRW reduction is a prime example, allowing new schemes to be deferred or at least reduced in scope, with significant savings.

Leakage is regarded as a legacy from ancient distribution systems. This is not always true (e.g. Chonburi, Thailand, where leakage levels were proved to be higher in newer parts of the

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1/ The author is a Partner of Watson Hawksley and a Resident Partner of Watson Hawksley Asia, Singapore.

system). Authorities must be aware of the risk of leakage becoming a chronic problem - the need for urgent expansion to meet rapidly increasing demand must not lead to a decline in design, materials and construction standards.

What Can be Done?

Firstly, study and define the problem, quantify NRW components and develop a control policy concentrating on areas offering the best return on investment. Tackling leakage alone is not enough. Non-physical losses can account for a quarter (Bangkok and Chonburi) to a half (Manila) of NRW and can usually be reduced at less cost than leakage.

Leakage: - Passive control (repairing leaks when they are noticed) is usually inadequate and active control is needed (pressure control if there is scope, zoning of the system, with zone metering to monitor for suspected leaks, and systematic leakage detection). Review standard designs and pipe materials and construction specification for new extensions and strictly supervise contractors' work.

Non-phyical losses:- Authorized free use (fire-fighting, mains flushing and concessionary supplies) is a policy matter;

- Theft does not always occur among the low-income group. It can often result from bureaucratic inefficiency. In Manila (20% theft in some areas), it used to take 9 months and 17 signatures on the paperwork to provide a new connection - consumers cannot wait. Make sure supplies are available to the poor (stand pipes if necessary), use cross-subsidised tariff, amortise and cross-subsidise the charges for new connections, grant amnesties to encourage reporting of existing illegal connections, process new applications promptly and than impose deterrents.

- Meter under-registration. Institute regular meter rotation, and prompt servicing and recalibration. Train meter readers to spot likely faulty meters. Select meter types and sizes carefully to suit conditions and duty range. Check large consumer meters regularly.

- Under billing. Update and computerise consumer records. Review regularly for anomalies. Establish a sound basis for estimating consumption when meters are unserviceable. Rotate meter readers regularly. For non-metered consumers, set flat rate charges to reflect true usage, install throttle devices on in-house plumbing systems and institute public education campaigns against wastage.

Once an authority understands, defines and quantifies its NRW problem, developing a control strategy is relatively cheap and straightforward, involving fairly simple technology but a high level of commitment. It should not be very difficult for water supply authorities in developing countries to reduce NRW to about 15%.

14th WEDC Conference

Water and urban services in Asia and the Pacific

Kuala Lumpur 1988

DISCUSSION GROUP REPORT
Water resources

Chairman: Gourisankar Ghosh
Rapporteur: Zainuddin Hj Shamsuddin
Discussion note: G Ghosh & J C Srivastava

The group discussed the importance of the preservation of water resources. Emphasis was often given to water treatment and little attention or emphasis was given to the study of water resources, due to the lack of knowledge in the geological and geohydrological fields. Water resources had to be appreciated, for example in Central Australia there were places where there had been no rainfall for ten years. In India rainfall harvesting did not allow rainwater to flow into the sea.

Water resources had to be preserved and protected but in doing this social and political problems may be encountered. Resource management needed to be modernised and computerised. It was becoming more and more expensive to develop new water supply schemes. People were beginning to realise the importance of the preservation of water resources, for example in Malaysia, the formation of a National Water Resource Committee was proposed. A more integrated and more coordinated approach to water resource management was needed. People must be trained to accept and use modern technology.

14th WEDC Conference

Water and urban services in Asia and the Pacific

Kuala Lumpur: 1988

National Technology Mission on Drinking Water in India

G. Ghosh and J.C. Srivastava

As a signatory to the Alma Ata Declaration for providing safe drinking water to the entire rural population in India by 1991, Government of India (GOI) had launched a massive Rural Water Supply and Sanitation Programme. In order to develop an appropriate management system, a holistic approach towards solution of rural water supply and to achieve this goal by integrating various scientific innovations and knowledge in the country, GOI set up in 1986 a Technology Mission on Drinking Water in Villages and Related Water Management. The Mission aims at the scientific study and evolution of cost effective solutions by mobilising all possible avenues and pooling the resources of national scientific institutions like the Council of Scientific & Industrial Research (CSIR) and government departments like Science & Technology, Space, Atomic Energy, Defence Research, Ground Water Board, etc. A number of Universities, academic institutions, research bodies, voluntary organisations, CAPART and UNICEF are participant. The Mission is target specific, research specific and time specific. The Department of Rural Development, GOI, (DRD) is the nodal agency of the Mission.

INDICATORS

The Mission would seek to provide by 1990, solutions for problems of 2,27,000 problem villages (36 percent of all villages) defined as no source i.e. water sources at more than 1.5 km distance or 100 metres elevation difference and water scarcity (1,54,000 villages), biologically contaminated (44,000 villages) and/or chemically contaminated (29,000 villages).

HARNESSING TECHNOLOGY

Activities under this involved (i) collection of basic data at micro-level for identification of problem; (ii) determination of matching S&T solutions including technology mix; identification of related S&T institutions to solve the problem; (iv) identification and application of high technologies; and (v) identification of technological gaps and sponsoring short-term Research and Development projects. Keeping in view the priorities, the technologies and related practices adopted by the Mission are presented below:

1) Source finding (see Fig. 1)

Integrating Remote Sensing (Satellite imageries and their interpretation to sense ground water zones), Geohydrological Studies and Geophysical exploration to provide fast solution for locating drilling sites. These techniques have helped in minimising drilling failure of borewells and provided assured creation of new sources. Success rate of wells drilled are 95 per cent, while the cost of geophysical studies estimated to be less than 5 per cent of the cost of drilling Instruments (battery operated) for measuring earth's resistivity (NGRI, India) for ground water prospecting are in wide use. Other activities relate to space mapping and mathematical modelling.

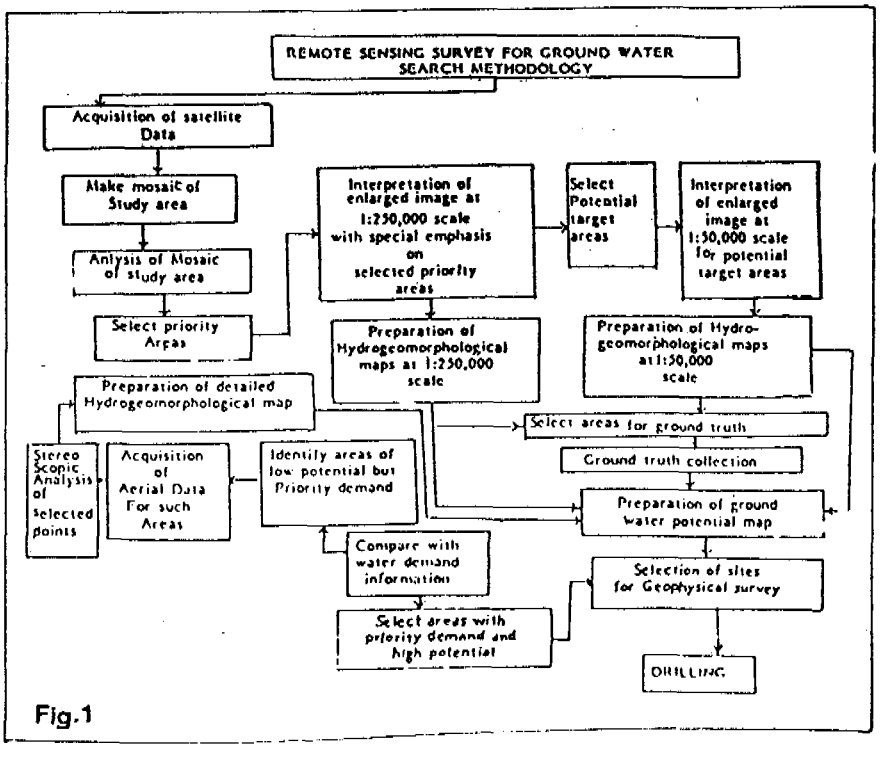


Fig.1

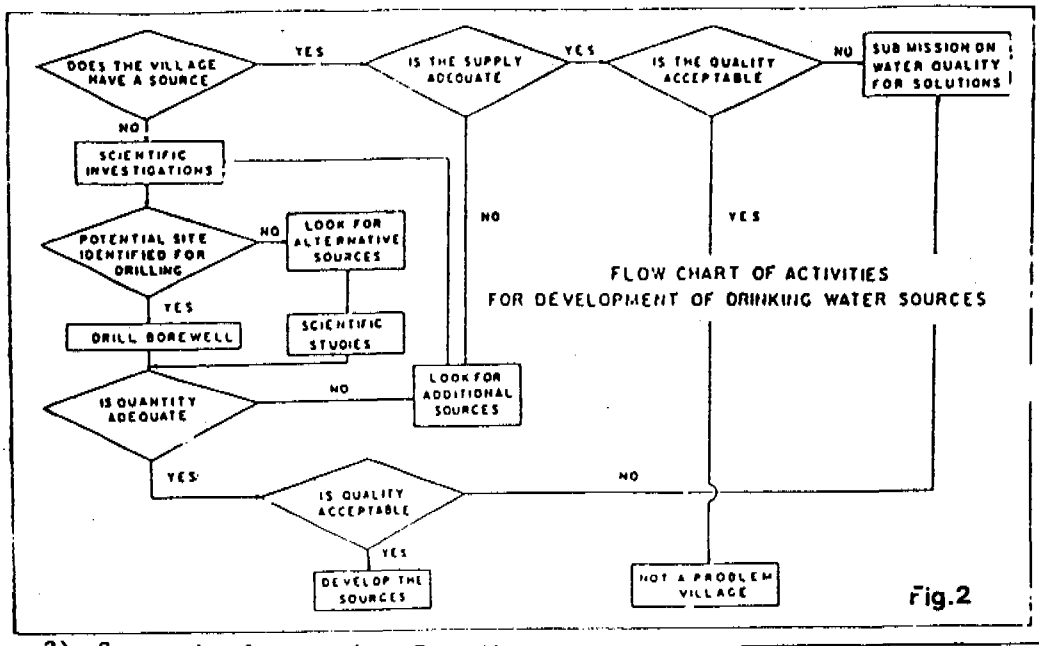


Fig.2

ethanol developed by NCL, India); and use of plasticulture for reducing seepage losses, conserving soil moisture and controlling leakage in transportation of potable water. A continuous ground water monitoring has also been proposed. The technology involves a blend of traditional methods and modern techniques leading to replicable strategies.

2) Source development (see Fig. 2)

Borehole loggers (NGRI) are used for stratiographic investigations followed by test drilling. Other activities include making the maximum number of drilling rigs functional and drilling of production wells for installation of tubewells and deep/shallow well hand pumps (like India Mark II) and borehole coding for future use. UNICEF is assisting in this work. This also involves use of solar energy water pumping through windmills and photovoltaics (NAL/CEL,India).

3) Water management

Main inputs include an integrated water management policy for conjunctive use of surface and ground water (including irrigation sources); ecological management particularly in catchment (including remote hills) and development of appropriate crop strategies and promotion of scientific irrigation practices. Water budgeting and computer optimization of water management are also being worked out. Ground water augmentation and water conservation include activities like aquifer testing, modelling recharge estimates and rate (radio isotope studies); identification of secondary sources of water including sub-surface water (their tapping, conserving, optimally using and replenishing); minimization of surface run-off through check dams; site specific water storage structures (see Fig. 3) using ferrocement technology; water conservation and rain water harvesting system (CAZRI, India); renovation of existing catchment; reduction in evaporation losses in surface water bodies using chemical film (alkoxy

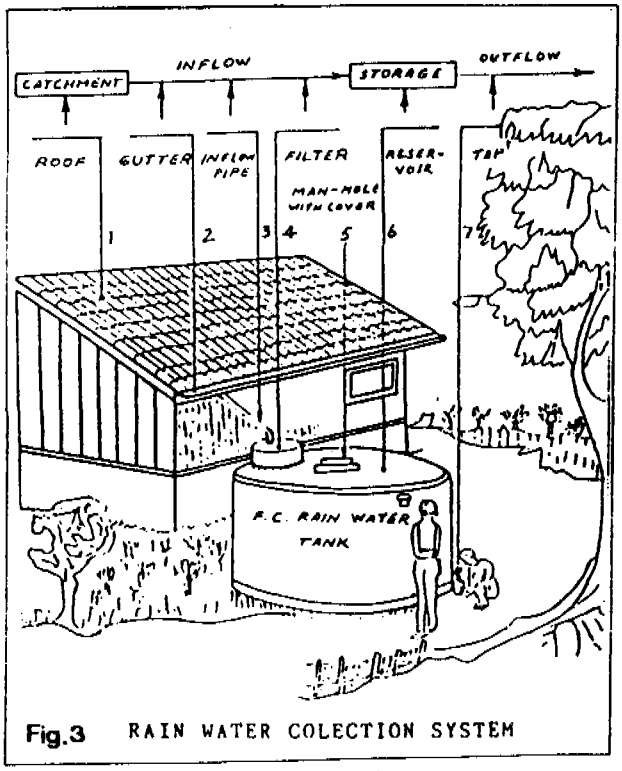


Fig.3 RAIN WATER COLECTION SYSTEM

4) Water quality assessment (12 parameters as per WHO norms)

Continuous monitoring of water quality has been considered to be the most important activity to be adopted all over the country in every district(an administrative area in India). Efforts are being made to establish stationery and mobile water testing labortories and training of laboratory technicians. Battery powered portable water analysis kits have been developed for on the spot tests. NEERI has prepared (1987) two manuals (see Fig. 4).

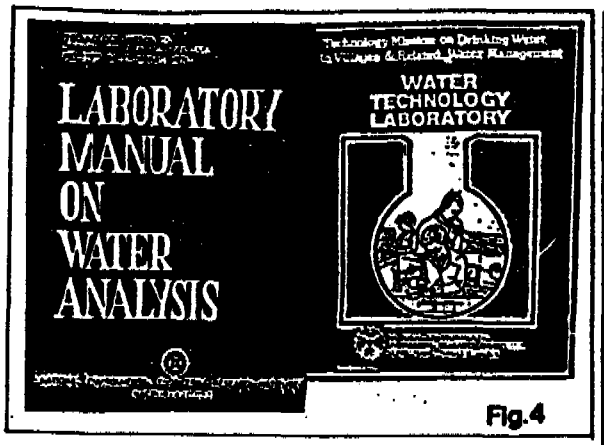


Fig.4

5) Control of guineaworm
(target - eradication of guineaworm from all problem villages by 1989)

The curative meassures involve vector control by use of Temephos, personal prophylaxis and treatment of patients. The preventive measures include alternate water source finding, conversion of step-wells into sanitary wells and intensive education programme (See Fig. 5).

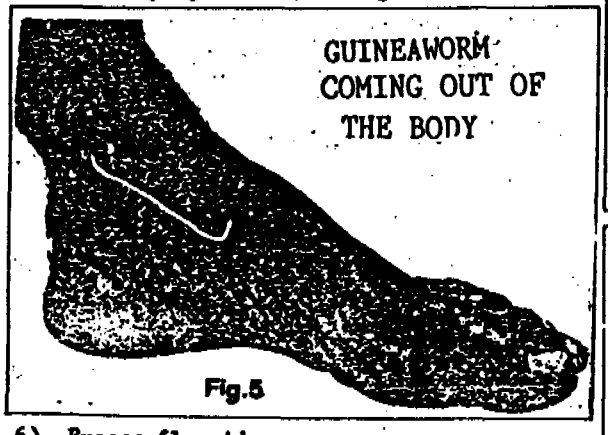


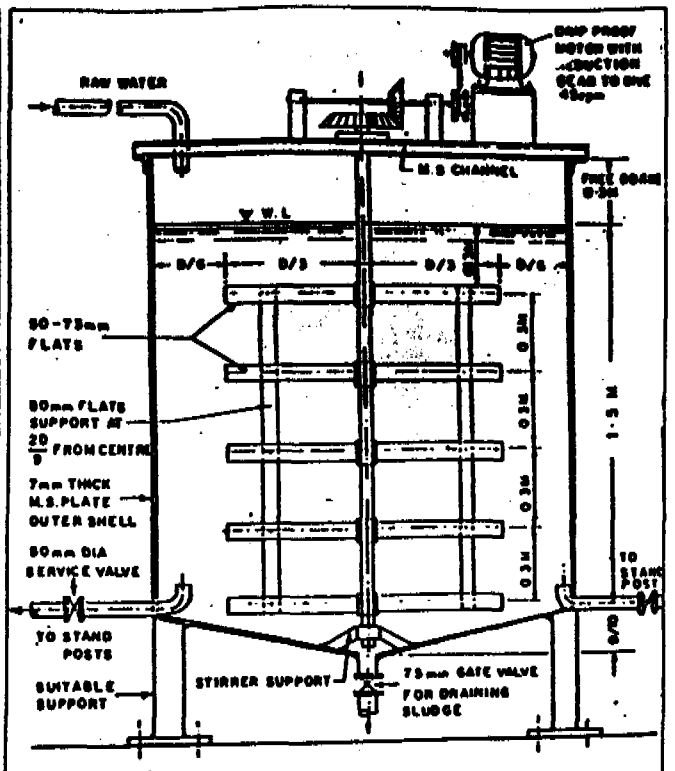
Fig.5

6) Excess fluoride
(permissible limit 1 mg/litre)

This involves new source finding and treatability study of problem source. Fill and draw type treatment based on NEERI technology (see Fig. 6) has been found cost effective and appropriate for local maintenance. Technology package has been prepared to facilitate turn-key delivery in villages. NEERI has also introduced house-hold treatment where prescribed chemicals are thoroughly mixed for 20-30 minutes, stirred and allowed to settle for one hour. Superantant water is tapped for drinking.

7) Excess iron
(permissible limit of Fe 0.3 mg/litre)

This inolves new source finding/undertaking study of problem sources. Treatment technology developed by NEERI involves aeration of water over a series of coke beds, pH adjustment followed by sand filteration



FILL AND DRAW TYPE DEFLUORIDATION PLANT
BASIS: 40 lpcd DOMESTIC WATER
(FOR POPULATION UPTO 200)

D= DIAMETER OF PLANT.

Fig.6

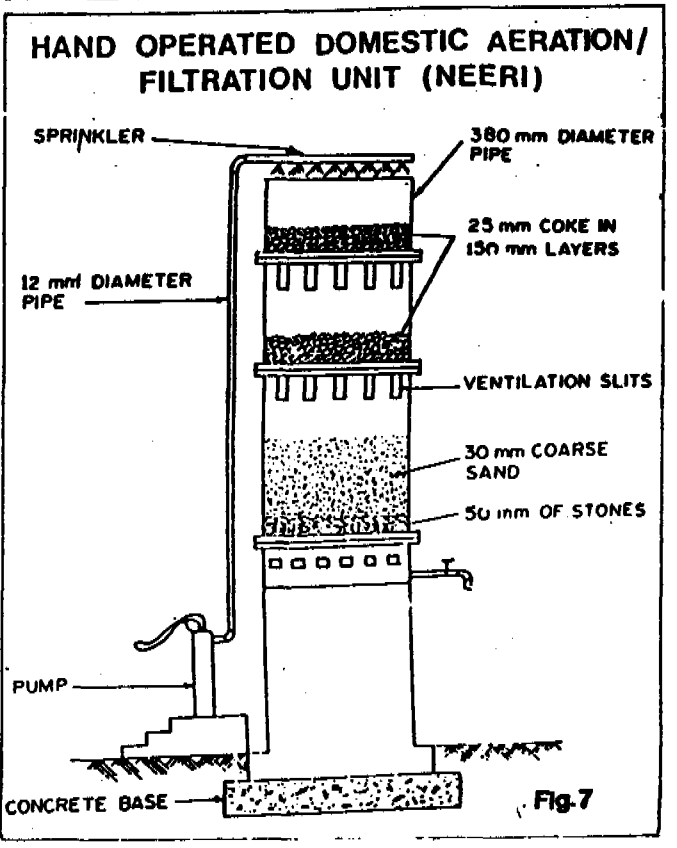


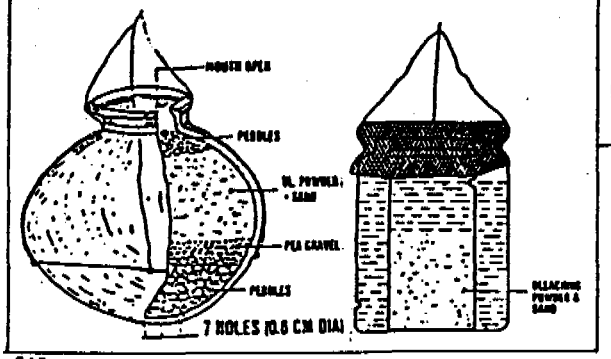
Fig.7

(see Fig. 7). Technology package has been prepared to facilitate turn-key delivery in villages. NEERI has also developed (i) muscle power (manually operated) dissolved air floatation unit(see Fig.8); (ii) dometic chemical treatment method; and (iii) handpump connected aeration filteration unit.

8) Bacteriological contamination (most probable number-0)

The solution involves chlorination through pot-chlorinators (see Fig.9), use of filter candle and scientific disposal of human waste. Education in water hygiene forms a major activity. UNICEF is providing inputs to this effect.

Fig.9 *Double pot chlorinator*



9) Removal of impurities (organic matter, disease carrying organisms and turbidity) (permissible limit - 2NTU)

In addition to slow sand Filteration (see Fig. 10), NEERI has also developed an innovative compact water Treatment Plant incorporating chemical coagulation, sedimentation and filteration. This unit can also be operated manually.

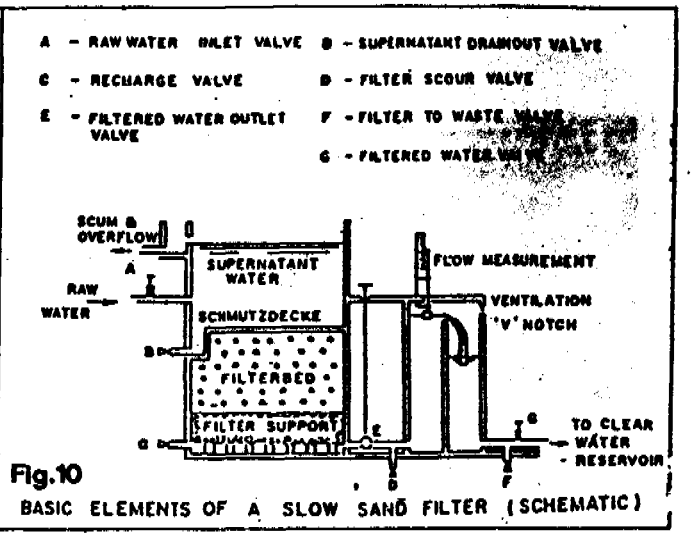
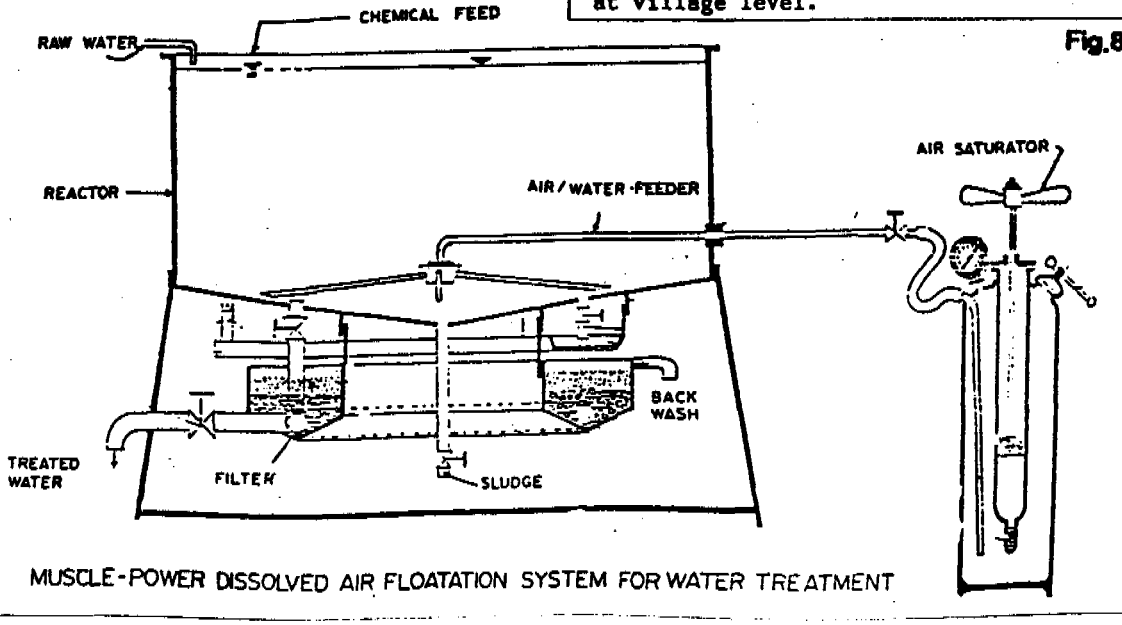


Fig.10
BASIC ELEMENTS OF A SLOW SAND FILTER (SCHEMATIC)

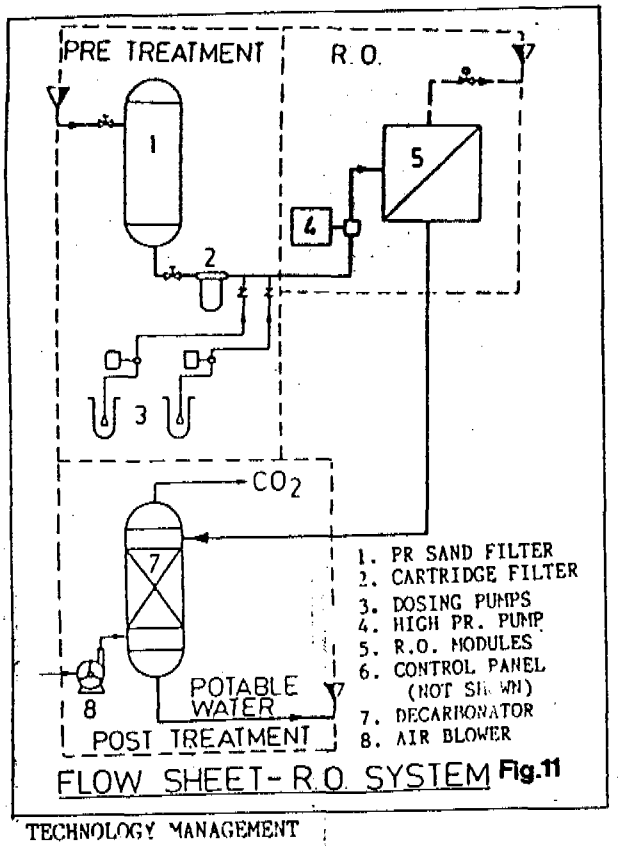
10) Salinity/brackishness (permissible limit 1500 ppm TDS)

Alternate source finding and cost effective (optimum distance based) potablewater supply; failing these installation of Electrodialysis (ED) or Reverse Osmosis (RO) plants(see Fig.11) to desalinate water upto 5000 ppm and 10,000 ppm respectively have been taken up (CSMCRI, BARC and DL,Jodhpur,India). This includes preparation of feasibility/project report for the source and population. CSMCRI, India based mobile RO plants 15 m /day capacity are also being used for scattered villages. The mobile unit has proved most successful for demonstration and generation of confidence among beneficiaries for use of technology. All these plants use cellulose acetate membrane based on indigenous technology and are manufactured in India. These have been found appropriate in terms of maintenance by local skills at village level.

Fig.8



MUSCLE-POWER DISSOLVED AIR FLOATATION SYSTEM FOR WATER TREATMENT



FLOW SHEET-R.O. SYSTEM **Fig.11**

TECHNOLOGY MANAGEMENT

This involves determination of role of participating institutions and agencies for providing necessary S&T and related inputs; (ii) preparation of technology package with engineering data; (iii) prepration of maintenance manual; (iv) preparation of micro-level project reports; (v) identification of suppliers of hardware and other inputs of technology; (vi) installation, training, maintenance of technology and feedback mechanism; (vii) activities relating to enhancing performance and cost effectiveness of current technological practices;(viii) provision of team of experts including geohydrologists; (ix) setting up of net work of simple water quality testing facilities; and (x) training in source finding and development, water quality testing, maintenance of treatment plants and rain water harvesting techniques.

All these inputs have been dovetailed into an integrated action-plan with tangible physical, financial and time milestones.

Coordination of S&T activities with all the related scientific institutions and expert agencies is being done by CSIR, India. To this effect, a Memorandum of Understanding (MOU) was concluded between DRD and CSIR in June, 1987. CSIR has engaged the National Industrial Development Corporation (NIDC) a public sector undertaking of India to provide detailed engineering for various technology packages. NIDC also provides support to DRD in monitoring and management information system(MIS).

RESEARCH AND DEVELOPMENT (R&D)

In order to bridge the technological gaps and to face the emerging needs and problems following short term (2-3 years) duration R&D projects have been undertaken (1987) by CSIR laboratories:

(i) Control of guineaworm reactor cyclops using controlled release abate (téme phos); (ii) Development of rapid water analysis kits; (iii) Development of field testing of software for rapid interpretation of geo-electrical exploration; (iv) Saline fresh water interface dynamics in coastal aquifers and saline water movement with time; (vi) Evaluation of polymern long chain alcohol and aloxy ethanol mixed mono-layers for water evaporation control at high wind velocity; (vii) Identification of suitable plant species for biological water purification; (viii) Development of shallow well hand pump; (ix) Development of filteration technologies for safe drinking water; (x) Development of combined RO-ED techniques for sea water desalination; (xi) Prospecting of ground water through phreatophytes; (xii) Bacteriological test for early detection of faecel pollution;and (xiii) Development of instruments ofwater quality monitoring.

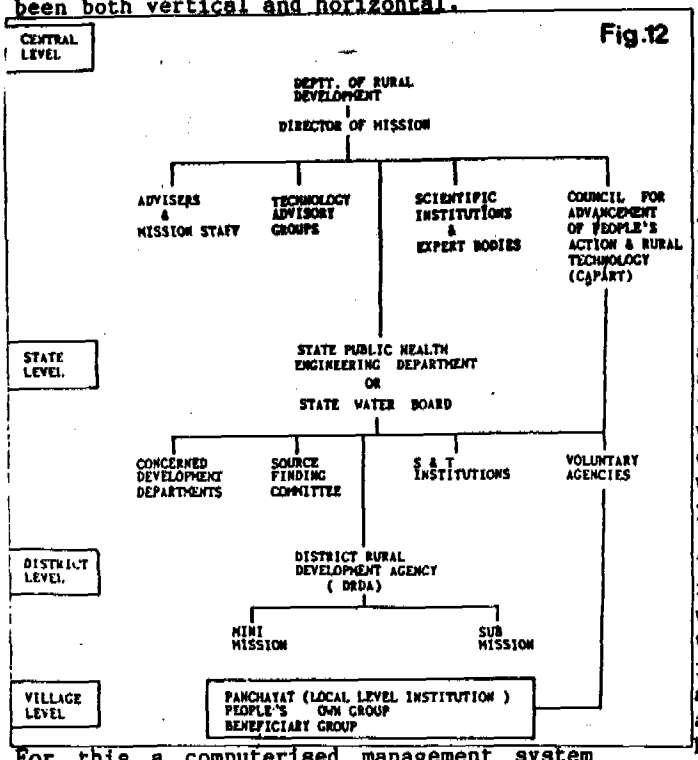
PEOPLE'S PARTICIPATION

A massive compaign for creating public awareness has been worked out by demystification of technologies through awareness camps, audio-visuals, demonstration; training of trainers and beneficiaries; mobilization and sensitization of voluntary agencies, government staff and technical personnel, local leaders and women groups. This is supported by seminars/workshops at managerial level. Assistance of voluntary agencies and UNICEF is being sought for these activities.

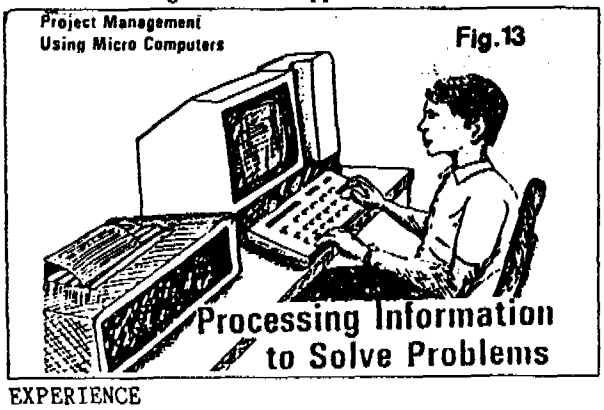
MANAGEMENT OF THE MISSION

The Mission has a three tier organisational linkage (see Fig. 12) with defined responsibilities and clear cut guidelines. In order to develop cost effective models scientifically at grassroot level, the Mission has identified 55 Mini Mission districts (an administrative area in India) in the country which silmultaneously will provide technology package for the ongoing Rural Water Supply Programme aimed to cover nearly 50,000 villages a year till 1990. Five Sub-Missions have been developed for clear focus on solution of priority problems (discussed earlier)and scientific water targetting along with conservation of water. The diversity of geographical regions,needs and problems of people, technologies and implementing agencies pose a massive management problem. This

is being tackled by the matrix management approach wherein information flows have been both vertical and horizontal.



For this a computerised management system has been developed (See Fig. 13). Technology Advisory Groups(TAGs) formed by the Mission, bring together the scientists, water supply authorities and engineers to exchange experience and formulate policy and action in furthering the S&T approach.



EXPERIENCE

In the first year of the implementation of the Mission,it has been felt that data assimilation and dissemination is a major task for managing a programme for as large as Rs 10000 million (US $ 770 million at Rs 13.00 December,1987)and more in a year covering 50,000 villages in the country. It requires application of modern Management Information System (MIS) to make the Mission more effective (besides scientific inputs and cost effectiveness). Emphasis has been given to proper Rig Monitoring System (with the help of UNICEF), Handpump Maintenance System with Public Health Engineering Departments at the state level and MIS at district headquarters. As a part of these activities, each district has been given a computer where all the relevant information on water supply and sanitation would be available not only to the implementators of the programme, but also to the people and their representatives. This will be a breakthrough because one of the major attempts of the Mission is not only demystification of science and technology, but also increase of people's awareness and their participation in implementation as well as in maintenance and conservation of water. The Mission also experienced that mere emphasis on the groundwater may not lead to a sustained water supply, but water quality testing coupled with proper rain water harvesting will solve the problem in the long run particularly in the arid and semi-arid regions of the country. The technology to be applied in these areas will not only restrict itself to the hardware of the water supply schemes, but also to the totality of water management which would include agricultural pattern, preventive actions for drought and above all a general awareness for conservation of water and knowledge of personal and community hygiene

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List of abbreviations

NGRI-National Geophysical Research Instt., Hyderabad-500007, India
NEERI-National Environmental Engg. Research Instt., Nagpur-440020,India
NCL-National Chemical Laboratory, Pune-411008, India
NAL-National Aeronautical Laboratory, Bangalore-560017, India
CEL-Central Electronics Ltd. Sahibabad, Delhi, India
SERC-Structural Engineering Research Centre Ghaziabad (UP), India
CSMCRI-Central Salt & Marine Chemicals Research Institute, Bhavnagar-364002
CAZRI-Central Arid Zone Research Institute, Jodhpur (Rajasthan), India.
DLJ- Defence Laboratory, Jodhpur, India.
BARC, Trombay, Bombay, India

14th WEDC Conference

Water and urban services in Asia and the Pacific

Kuala Lumpur 1988

DISCUSSION GROUP REPORT
Water treatment

Chairman: L G Hutton
Rapporteur: Ahmad Zaidon Rais
Discussion note: Dr Peter Okoye

The principles of slow sand filtration were described and some delegates expressed surprise that new SSF plants were being commissioned today and that major cities such as Madras, Hamburg and London were still using them. It was felt that SSF needs to be "rediscovered" and sold as the latest technology being very important to developing countries. Its advantages included simple design and construction, little or no imported components, no chemcials needed to be used or imported and maintenance was straighforward and machinery intensive rather than manpower intensive. The use of geotextiles, both at the base and on the surface of the filter, proved useful in the experiences of several delegates. The major disadvantage was clogging due to high turbidity waters. The group went on to discuss alleviation of turbidity by the use of infiltration galleries, plain sedimentation tanks, impounding reservoirs, mining ponds and horizontal roughing filtration.

The chairman described the design of horizontal roughing filters at an operational plant at Matale in central Sri Lanka: 3 channels 10 m long x 3-4 metres trapezoidal section, 1-2 metres deep, filled with rock boulders produced a product water of 15 NTU which was then treated by SSF. Kampsax-Kruger of Denmark had installed the plant and it had operated satisfactorily for eighteen months so far. The cleaning by high pressure hosing and backwashing was described. Delegates were referred to the IRCWD work in horizontal roughing filtration (see references). The potential of HRF for other treatment processes was pointed out.

The operation and upgrading of "conventional" treatment processes led to several valuable suggestions that indicated that operation could be modified and improved by such things as varying levels in tanks and channels, careful control of backwashing filters and varying dosing points and dosage. The correct use of polyelectrolytes was hard to determine and it was suggested that on-plant tests with realistic amounts of various types of polyelectrolytes with alum was needed for certain periods of the year. Polyelectrolytes were expensive but had been useful in several cases. The importance of keeping records was stressed by a delegate from Penang and was endorsed by other operational staff and consultants.

No solutions to recycling waterworks alum sludge were offered. Ozonation as a disinfectant required constant power and left no residual so was to be discouraged. It had potential for industrial water treatment since it left no taste or smell.

The problems of treating groundwater, and especially shallow wells drawing water by buckets, were highlighted in a paper by Dr Peter Okoye from UNCHS, Pakistan. Chlorination and monitoring chlorine presence were not thought to be technical problems. The major difficulty was involving the refugees in participation and health education programmes.

Overall the participants covered a wide range of alternative treatment technologies for urban and rural supplies. The most appropriate combination to produce the safe water required was the role of the engineer in consultation with the community. It was also stressed that unless consultants were briefed properly, conventional treatment with its high running costs and maintenance problems would probably be supplied.

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IRC 1983 Technical Paper 18. Technology of small water supplies IRCWSS, Den Haag, The Netherlands

14TH WEDC CONFERENCE: WATER AND URBAN SERVICES IN ASIA AND THE PACIFIC

MAINTAINING WATER QUALITY ON IMPROVED UNCOVERED SHALLOW WELLS - METHODOLOGY

DR. PETER OKOYE

FOCUS OF DISCUSSION: HOW CAN WATER QUALITY BE MAINTAINED IN IMPROVED, BUT UNCOVERED SHALLOW WELLS USED BY REFUGEES? IS CHLORINATION EFFECTIVE?

Introduction:

There are about 3 million Afghan refugees in Pakistan. The Afghan refugee program represents the largest single refugee program in the world under the management of the United Nations High Commissioner for Refugees (UNHCR). The refugees live in dispersed refugee villages located mainly in the settled and tribal areas of NWFP, Punjab and Baluchistan Provinces.

Health Program:

The Afghan Refugee Health program is a collaborative effort between the Government of Pakistan and UNHCR. It is largely promotive, curative and preventive and involves many voluntary agencies.

Environmental Sanitation:

Environmental Health services are delivered through an integrated Primary Health Care approach with a strong emphasis on refugee involvement. Major obstacles affecting implementation in this sector are largely socio-cultural in nature.

Water Supply:

Water for the Afghan refugees are provided through piped schemes (tube wells), water tankers, improved shallow wells, unimproved shallow wells and other natural sources (spring, canals and rivers). UNHCR places major emphasis on the use of improved shallow wells to meet the water needs of the refugees where there is available ground water. In 1987, UNHCR spent US$ 4,132,665 for refugee water supply. 1 US$=Pak Rs.17.44.

Shallow Well Improvement program:

The shallow well improvement program is implemented by four voluntary agencies in NWFP and Baluchistan. The voluntary agencies are funded and monitored by UNHCR. The emphasis on shallow well improvement and justification for it are based on the following:

(a) It is labour intensive; does not require extensive technology nor importation of construction materials out of the country; the voluntary agencies provide only construction materials and skilled labour while unskilled labour is provided by the refugees. The refugees are, therefore, involved in the construction which is an essential element for subsequent upkeep of the wells.

(b) It is a reliable water source, particularly, if the improvement was carried out adequately and efficiently.

(c) It is very cost effective in comparison to piped schemes. The per capita cost of improving a shallow well is Rs.21.50 as against Rs.46.50 for a piped scheme. The cost differential becomes significant for a refugee population of 3 million.

The design and workmanship applied in the improvement of the wells are of exceptional quality. The Afridev pump-a hand pump will be used to cover the wells in due course.

NUMBER OF REFUGEES USING WATER FROM IMPROVED SHALLOW WELLS

The data from Table 1 shows that nearly 50% of the refugee population in NWFP depend on improved shallow wells while in Baluchistan 7% benefit from the improved wells (ground water availability is limited in Baluchistan). Using the total refugee population in Baluchistan and NWFP for calculation purposes, more than 60% of the refugees, therefore, rely on improved shallow wells to meet their water needs.

TABLE 1

Number of Improved Shallow wells and Beneficiaries in Baluchistan and NWFP as of December 1987

Province	Refugee Population	No. of Improved Shallow Wells	No. of Beneficiaries	% served	Average No. of users per well
BALUCHISTAN	818,177	604	57,749	7.05	95-105
NORTH WEST FRONTIER PROVINCE	2,157,482	5,725	1,054,200	48.8	180-210
TOTAL	2,975,659	6,329	1,111,949	---	---

** US$ 973,491 was spent by UNHCR on shallow well improvement & maintenance in 1987. US$ 3,159,174 was spent by UNHCR on piped schemes/water tankers in 1987.

Chlorination Programme:

An improved well without any form of cover is subject to contamination. Bacteriological tests carried out on a randomly selected improved wells in 1986/1987 showed that all the wells are grossly contaminated with fecal coliform (>240/100ml) which unfortunately were introduced into the wells during use. On the strength of (a) the results of the bacteriological tests, (b) the relationship that exists between contaminated water and the incidence of diarrhoea disease and (c) the fact that it will take a considerable time period before the wells are covered with a handpump, a request put forward by a voluntary agency to chlorinate half of all the wells systematically on an experimental basis was granted in late 1987. However, in granting the request, UNHCR stressed that the effectiveness of the chlorination program would depend largely on due consideration being given to other inter-related factors such as: adequate institutional arrangement to sustain the project; an aggressive educational program on personal and community hygiene to focus on the link between water/sanitation and disease and necessary knowledge to help the refugees break the chain of disease transmission; presence of a caretaker (a refugee leader) for each well to maintain the wells, periodic evaluation of the chlorination program and concentrating in areas with no piped water scheme, no sanitation projects and areas with high incidence of diarrhoeal diseases.

METHODOLOGY:

Several field investigators and scientists have reported that improved shallow wells can be effectively protected using the pot chlorination method (Oxfam, 1974; Feachem, 1978; WHO 1980; Feachem/Cairncross, 1983). After many experiments in the refugee camps, a modified version of the pot chlorination method was applied for the wells in Pakistan. The overall goal was to achieve breakpoint chlorination and maintain a free residual chlorine of .2mg/l in the wells. (The pot method was used initially but the refugees removed the pots because the level of chlorine released from the pot was too high and the refugees could not drink the water.) The procedure involved the use of a black plastic bag with one hole and a mixture of 300gm of bleaching powder (25-35% available chlorine) and 500gm of coarse sand (1-1.5mm particles). Chlorine dose for each well depended on the volume of water, the temperature and pH. A rope was used to lower the plastic bags into the wells once a month. Chlorine was gradually released into the water to ensure a free residual chlorine of a minimum of .2mg/litre for at least three weeks. Free residual chlorine, fecal/total coliforms were determined using portable field equipment.

Evaluation:

After three months, the chlorination program was evaluated. A key problem identified was that free residual chlorine was not detectable in more than 50% of the tested wells after one week. Sampling and data collection were not adequately carried out as stated in the original objectives.

Conclusion: The chlorination methodology needs refinement. It also brings into sharper focus the wider question: Is systematic chlorination of open wells cost effective and should shock chlorination not be an adequate measure until the improved wells are covered with handpumps?