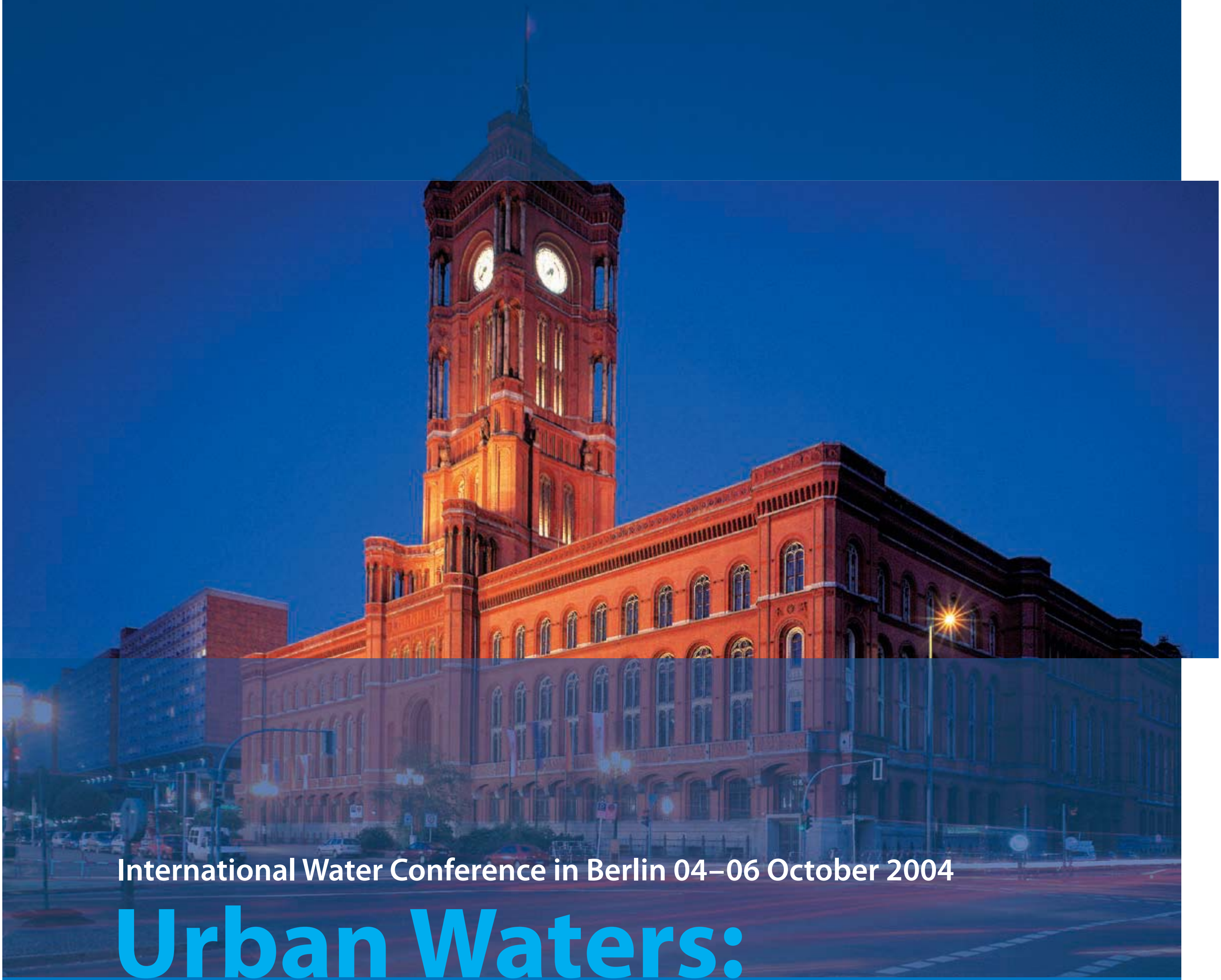
Documentation



International Water Conference in Berlin 04–06 October 2004

Urban Waters:

Problems and Solutions with regard to Sustainability

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Greetings

"Clean water and environmental conditions offering quality of life are fundamental rights for all." The millennium goal of the United Nations – to reduce by half the number of people who do not have access to clean water by 2015 – can only be achieved if the experience gained all over the world under diverse geographic, social, and cultural conditions on the subject of water can be pooled and analysed with an eye to achieving solutions.

It was thus a great pleasure for me to host the conference "Urban Waters: Problems and Solutions with regard to Sustainability - Wasserprobleme und Lösungsansätze in urbanen Räumen unter dem Gesichtspunkt der Nachhaltigkeit," which took place in Berlin from 3 to 6 October 2004. Delegations from Belgrade, Brussels, Budapest, Istanbul, Jakarta, Johannesburg, Cape Town, Ljubljana, Los Angeles, Mexico City, Moscow, Paris, Prague, Ramallah, Riga, Seoul, Shanghai, San Rafael del Sur, Szczecin, Tallinn, Tashkent, Vienna, Vilnius, Warsaw, Windhoek, and other cities came to participate.

We are all very much aware of the political and economic importance of water as a resource. The limited quantity of water on our planet must be used effectively. According to estimates, the consumption of water world-wide will increase by 650% by 2025, especially in metropolitan areas. With its focus on water quality, reducing water loss, and sewage management, the conference aimed at uniting the experience gained by different cities in managing water as a resource.

I was especially pleased to host this event here, since the "water city" Berlin has a great deal of experience in this field and, at the same time, is very interested in learning about other cities' solutions. Four companies – Berlin Centre of Competence for Water (KWB), Berliner Wasserbetriebe, BerlinWasser International, and Veolia Water – were ready to offer their expertise. The organising partners BGZ Berlin International Cooperation Agency, the Berlin Senate Chancellery, InWEnt - Capacity Building International, Technical University Berlin, and the European Academy, as well as my Senate Department, contributed to this multilateral exchange of know-how.

I am glad that during this conference we succeeded in creating the prerequisites for increasing either the efficiency of water use or international exchanges on this subject. More than 80 international experts and a great many local experts from public and private water companies, universities, and political and administrative institutions gave us insight into the various basic conditions operative in more than 30 cities around the globe, generated synergies, and worked out approaches to solutions.

I would like to express my sincere thanks to all the participants and to the organisers of the International Water Conference 2004 in Berlin. I hope that this documentation of the proceedings will be informative reading and will lead to a further exchange of experience.

Harald Wolf
Mayor of Berlin and Senator for Economics, Labour and Women's Issues

Conference Programme

Urban Waters: Problems and Solutions with regard to Sustainability

Sunday, 03 October 2004

18:30	Welcome & Get together Dinner	Introduction of guests Introduction to the conference programme Information on workshops & exhibition opportunities at the „Market of Opportunities“

Monday, 04 October 2004

Berlin Town Hall (Rathausstr./Jüdenstr. 1)

08:15	Registration to the plenary session Coffee/ Tea
09:00	Words of Welcome Harald Wolf, Mayor and Senator for Economics, Labour and Women’s Issues André Schmitz, Head of the Senate Chancellery Bernd Schleich, Managing Director, InWEnt - Capacity Building International Dr. Francis Luck, Director of Berlin Centre of Competence for Water (KWB) Dr. Hilde Hansen, BGZ Berlin International Cooperation Agency Barbara Unger, Moderator
09:45	Keynote Speech Water Management in Berlin – Challenges and Requirements Ludwig Pawlowski, Member of the Board of Berliner Wasserbetriebe and Vice President of Supervisory Board of Berlin Centre of Competence for Water (KWB)
10:25	Coffee/ Tea
10:55	Keynote Speeches Water Management in Mega Cities: Current Trends and Future Perspectives Prof. Dr. Asit K. Biswas, President of the Third World Centre for Water Management, Mexico-City Chances and Potentials of Worldwide Cooperation in the Water Sector Prof. Dr. hc. Dr. Ing. Denis Goldberg, Advisor to the Ministry of Water Affairs and Forestry, Republic of South Africa, Director of Community H.E.A.R.T.
12:15	Lunch Break
13:30	First Focus - Water Quality Current Research Activities in Bank Filtration and Artificial Recharge Systems Dr. Francis Luck, Director of Berlin Centre of Competence for Water (KWB)

	Second Focus - Water Losses I Reduction of Water Losses in Water Supply Mains Stanislaw W. Khramenkov, General Director of Mosvodakanal, Moscow
14:45	Coffee/ Tea
15:15	Second Focus - Water Losses II Key Issues in Water Demand Management Leading to Minimizing Water Losses and Increasing Water Savings Dr. Abdelkarim Asa'd, Former General Manager of Jerusalem Water Undertaking, Regional Water Consultant, Palestine Third Focus - Wastewater Management Vision of Advanced Decentralized Systems in Wastewater Management Boris Lesjean, Expert at the Berlin Centre of Competence for Water (KWB) Feedback & Outlook Barbara Unger, Moderator
19:30	Evening Reception (Bärensaal, Senate Department of the Interior, Jüdenstr.42) given by the Mayor of Berlin and Senator for Economics, Labour and Women's Issues, Harald Wolf

Tuesday, 05 October 2004

Berlin Town Hall (Rathausstr./Jüdenstr. 1)

08:30	Registration to the Workshops Coffee/ Tea		
09:00	Parallel Experts' workshops		
	Focus I - Water Quality: Moderator: Sven Aden Speech: The Problem of Eutro-phication of Rivers and Lakes Dr. Ingrid Chorus, Federal Environmental Agency (UBA) Speeches and Presentations from Partner Cities	Focus II - Water Losses: Moderator: Barbara Unger Speech: Measures to Reduce Water Losses Andreas Hüttemann, Karl Weiss GmbH & Co., Berlin Speeches and Presentations from Partner Cities	Focus III - Wastewater Management: Moderator: Ulrich Nitschke Speech: Advanced Treatment and Reuse of Wastewater Dr. Bernd Heinzmann, Berliner Wasserbetriebe Speeches and Presentations from Partner Cities
10:30	Coffee/ Tea		
11:00	Speeches and Presentations from Partner Cities Discussion	Speeches and Presentations from Partner Cities Discussion	Speeches and Presentations from Partner Cities Discussion
12:25	Reports in the plenary session, given by the workshop moderators Feedback and summary Barbara Unger, Moderator		
13:00	Lunch break		

Participating Cities

Europe

Belgrade (Serbia and Montenegro)
Brussels (Belgium)
Budapest (Hungary)
Istanbul (Turkey)
Ljubljana (Slovenia)
Paris (France)
Prague (Czech Republic)
Riga (Latvia)
Szczecin (Poland)
Tallinn (Estonia)
Vilnius (Lithuania)
Warsaw (Poland)
Wroclaw (Poland)
Vienna (Austria)

America

Los Angeles (USA)
Mexico-City (Mexico)
San Raphael del Sur (Nicaragua)
La Paz (Bolivia)
San Bonja-Lima (Peru)

Asia

Ankara (Turkey)
Ramallah (Palestine)
Seoul (South Korea)
Shanghai (China)
Tashkent (Uzbekistan)

Africa

Aleppo (Syria)
Algiers (Algeria)
Cairo (Egypt)
Johannesburg (South Africa)
Cape Town (South-Africa)
Kumasi (Ghana)
Tizi Ouzou (Algeria)
Tlemcen (Algeria)
Windhoek (Namibia)

Ocenania

Jakarta (Indonesia)
Surabaya (Indonesia)

Words of Welcome

André Schmitz, Head of the Senate Chancellery, Berlin

I would like to welcome you to Berlin, the city of water. With this, I do not mean to say that it rains particularly often here even though one might get this impression in these rainy autumn days. Rather I would like to point out that Berlin enjoys a particular abundance of water. Three rivers – Spree, Havel, and Dahme – run through Berlin. In addition, we have a number of lakes and have been blessed with a rich supply of groundwater, which helps our forests and parks to blossom.

For this reason alone, Berlin is a good venue for an international conference on water. Berlin, however, is also a metropolis that is open to the world. And we therefore know that nature has granted us privileges by offering us such an abundance of water, particularly when we compare it to other regions in the world. Here too, however, water is a resource that must be used economically because water supply is costly and we have to try and keep these costs down. These are luxury problems when you think of cities and regions where not even sufficient water supplied has been secured. Berlin and its partner cities are therefore committed to jointly developing solutions in the water sector and to learning from each other. Our motto is: “Think globally, act locally.”

Indeed, we all have to feel a shared responsibility if we want to improve water supply around the world. At their Millennium Summit in 2000, the United Nations agreed to reduce by half the proportion of people without sustainable access to drinking water and sanitation. Keeping this promise is considered to be a decisive precondition for reducing poverty and improving health standards around the world and also for preventing violent conflicts over this expensive commodity (when you take a look at the conflict between Israel and its neighbours, for instance, it becomes obvious that there will be no peace unless the scarce water resources are distributed evenly). In practice, this would mean that each day 280,000 people would have to be connected to the drinking water network and 384,000 people to the sanitation network. These figures easily show how tremendous the challenge is that we are facing. It is true that 90 percent of the people without adequate supply live in rural areas. However, the exponential growth of urban agglomerations in the poor countries has caused a dramatic aggravation of the supply problem in these areas, too.

These are facts. They show that there is still a long road ahead of us in the fight against poverty around the world. The motto is: water is the key.

There is no doubt that the international conference on water in Berlin is dealing with a topic of great urgency. If we want to solve the global water supply problems, we can only be successful if we learn from one another. The preconditions for this are good when you take a look at the list of participants in this conference. Around 100 top-notch experts from more than 30 cities will have an intensive exchange of ideas and experiences in the next three days. And I am sure that the outcome will be impressive.

Having said this, I wish you a lively exchange and a fruitful and productive conference. And I hope that you will have some time to take a look at Berlin. Those of you who wish to go to the waterside will only have to walk a block from the Berlin Town Hall to reach the banks of the river Spree. From there you can explore Berlin’s historical centre by boat or directly visit one of the city’s many museums – on Museum Island, for instance, which is part of the World Cultural Heritage and is also surrounded by the Spree. Our city, however, also holds many other sights and places worth seeing in store for you.

I hope that you will enjoy Berlin and maybe some of you will take a liking to Berlin and come back on a private visit. We are happy to be your hosts here today. Welcome to Berlin.

Bernd Schleich, Managing Director of InWent gGmbH (Capacity Building International, Germany)

Mr. Schmitz,
Ladies and gentlemen,

First I would like to thank the organizers – the Berlin Senate Department for Economics, Labour, and Women's Issues and the Berlin Development Cooperation Agency, which in cooperation with many partners and with the support of Capacity Building International have been responsible for hosting this international conference on "Urban waters: problems and solutions with regard to sustainability."

I would like to welcome you on behalf of Capacity Building International and, for various reasons, its a special pleasure for me to do so here in Berlin, in the Berlin Town Hall:

Capacity Building International and the Berlin Senate have been cooperating closely in the field of national and international promotion of education within the framework of development cooperation for a long time.

The diversity of nationalities represented within Berlin's city partnerships corresponds to Capacity Building International's work around the globe and reflects the international composition of participants of our training and dialogue activities.

The fact that Berlin was chosen as the venue for such an important conference underscores Germany's special reputation as a location for science and academics.

These aspects are an integral element of Capacity Building International's mandate in the field of development cooperation. The organization acts on behalf of the Federal Ministry for Economic Cooperation and Development and is globally responsible for international human resources and organizational development through dialogue and training. Each year, more than 45,000 participants take part in Capacity Building International's offerings, such as training courses, seminars, and workshops. In addition, more than 10,000 participants use our virtual Internet-based programs. With our work, we mainly help to qualify people in developing countries. People who, on the basis of solid knowledge and experiences, initiate and implement development processes in their countries, their institutions, and their companies – in short, we are responsible for capacity building. And we believe that capacity building always starts with the people.

Capacity Building International's diversity is also reflected by the three organizational units which have participated in the organization of the conference:

The Regional Centre Berlin/Brandenburg whose core responsibility is development-related educational work and regional program monitoring in Berlin and Brandenburg. Part of the development-related educational work is, for instance, the Internet-based "Ch@t der Welten", which will for the first time this year deal with the issue of "Water in Southern Africa." For this, we have been able to win Professor Goldberg, advisor to the South African Ministry of Water Affairs and Forestry as a partner. I am pleased that Professor Goldberg has accepted our invitation to this conference and would like to cordially welcome him.

The Service Agency Communities in One World promotes, at the local level, the exchange between and networking of all those parties who deal with development tasks. Here, the great potential that our citizens provide for sustainable global development in accordance with Agenda 21 is addressed.

Last but not least, our Division for Environment, Energy, and Water has participated in the organization of this conference. This division is responsible for the "Global water resources" field of action. This field of action aims to initiate and accompany development processes in order to counter the resource's scarcity with applied technologies and specific management approaches. The skills of (up-and-coming) executives in the water sector will thus be strengthened through strategic alliances and partner networks on the ground.

I am very pleased that Professor Biswas, one of the internationally renowned experts in the water management sector, President of the Third World Centre for Water Management, and for many years a strategic partner in the development of our water program and friend of Capacity Building International has also accepted our invitation. As has Dr. Asa'd, the former General Manager of Jerusalem Water Undertaking, who has come all the way from Palestine. You have developed important models for the organizational development of waterworks in the Middle East and will certainly be able to contribute these insights during the conference. Welcome to Berlin.

We shall be happy to share Capacity Building International's and our networks' experiences with you during this water conference in Berlin, particularly since the Millennium Development Goals (MDG), and in this connection especially the seventh millennium goals of securing a sustainable environment (with the subtitle "reduce by half the proportion of people without sustainable access to safe drinking water"), constitute a particular challenge for the international community.

The German government is committed to this goal. It has pooled its development activities in the 2015 Action Program, whose item 6 takes up MDG7 and aims at achieving sustainable management of water resources.

This is the basis for Capacity Building International's water portfolio, which imparts extensive knowledge in the areas of:

- water sector policy
- cross-border management of resources
- integrated management of water resources
- housing estate water management and
- rural/agricultural water use

Technical know-how is analyzed from an interdisciplinary perspective and related to a broad range of methodological skills. This in turn is underpinned by promoting regional cooperation in order to develop practical approaches to solutions. In this connection, initiating and accompanying networks and intensifying the dialogue between all stakeholders is of particular importance. This is an integral element of our activities in the water sector and it reflects our conviction that responsible community action – at home and abroad – is a successful answer to the challenges of our environment.

I am sure that the discussions during the following days will further promote the establishment of networks between Berlin and its partner cities. With this in mind I wish you an interesting conference and a fruitful exchange of experiences.

Thank you for your attention.

Dr. Hilde Hansen, Managing Director of the BGZ Berlin International Cooperation Agency GmbH

Dear guests and participants from partner cities,

Welcome in Berlin on behalf of the BGZ Berlin International Cooperation Agency GmbH. As co-organiser and coordinator of this conference we are very happy to welcome you at the International Water Conference here in Berlin.

The BGZ is a joint private and public sector institution, funded by the Berlin State Government, the Berlin Chamber of Small Business and Skilled Crafts and the Berlin Chamber of Industry and Commerce. We manage, coordinate and implement international cooperation projects with focus on professional and vocational education, small and medium-sized enterprises and integration of immigrants. In doing so, we concentrate on those countries which have a special relation to Berlin:

- Turkey, because of the large Turkish community in the city,
- Poland, because of the geographical proximity in a common economic area
- All partner cities of Berlin.

Our aim and task is to contribute to the international integration of Berlin, for example through cooperation and conferences with partner cities. The conference "Best Practices – Supporting Women Establishing and Running Businesses in Berlin and its Partner Cities" which was very successful last year marked the beginning of a coming series of conferences on different topics.

The conference topic of this year "Urban Waters: Problems and Solutions with Regard to Sustainability" was selected in view of the work done during the international year of drinking water in 2003. Priorities for further action in the water sector defined there shall be integrated into future cooperation between partner cities.

Finding solutions to the diverse water problems around the world is a key to sustainable development. According to estimates, worldwide water consumption will increase by about 650 percent by 2025. Every year, investments of 75 billion will be necessary to cover the increasing demand for water. As a result of urbanisation, population growth, growing economies and higher living standards, water will become a more and more limited resource. In view of these developments, innovative solutions are required to manage water resources in urban areas.

Berlin's Senate Department for Economics, Labour and Women's Issues together with the BGZ has initiated this conference in order to discuss the respective problems within the water sector as well as to exchange know-how, best practice and possible solutions.

We hope this conference will be a foundation for exchanging experiences, fostering international cooperation and bearing a large amount of international projects in the future. We would be pleased to be at your command as partner for future projects.

I wish you an interesting and convenient stay in Berlin.

Plenary Session

Conference Proceedings, Barbara Unger, Moderator

On October 4th, 2004, more than 100 international experts in urban water management gathered in Berlin Town Hall to inaugurate a three-day conference for exchanging experiences on pressing issues of Urban Water Management.

WORDS OF WELCOME
On behalf of the Senate of Berlin, Mr. Andre Schmitz, Head of Senate Chancellery, opened the conference by drawing attention to Berlin's special relation with water issues. He highlighted the Senate's will to share the specific experiences of Berlin and to facilitate the exchange with its partner cities around the world.

Mr. Bernd Schleich, Managing Director of InWEnt Capacity Building, underlined the role of international cooperation and capacity building for reaching the Millennium Development Goals related to water.

Dr. Francis Luck, Director of Berlin Centre for Competence for Water, explained Berlin's approach and innovation capacity as an input not only for this conference, but for cooperation in the water sector in general, highlighting research projects on artificial recharge systems and bank filtration.

Dr. Hilde Hansen of BGZ Berlin International Cooperation Agency GmbH focussed on BGZ's role in Berlin's development cooperation efforts, and specifically, in organizing this conference.

After these introductory words, Ms Barbara Unger, the moderator of the conference, introduced the objectives and the program of the conference ahead. She highlighted the importance of exchange to take place at different stages (the discussion in the plenary, the working groups and the market of opportunities, as well as informal exchange during the breaks and the evening reception) and the role of the frame-setting keynote speeches and thematic inputs to follow, first on water management situation and issues in Berlin, then from a global perspective, and finally from a South African perspective. The three issues chosen to be the main focuses of the event, namely Water Quality, Water Losses and Wastewater Management, would be introduced by plenary presentations from Berlin, Moscow, Palestine, and again a Berlin perspective.

KEYNOTE SPEECHES
Mr. Ludwig Pawlowski, Executive Director Technology and Board Member of Berliner Wasserbetriebe (Berlin Water) gave the first keynote: „Water Management in Berlin – Challenges and Requirements“ by giving an insight into Berlin's water situation and the installations and techniques used by Berliner Wasserbetriebe. First Remarks in the brief discussion to follow raised the issue of transfer: it was not felt possible for the majority of conditions to deal with water management the way Berlin can, both from its rich water supply and from its income that allows to use latest technology.

Prof. Asit K. Biswas, President of the Third World Centre for Water Management, put global trends and a scientific perspective at the centre of his keynote presentation on „Water Management in Mega Cities: Current Trends and Future Perspectives“. He highlighted current trends in urban development and global population growth, and called for holistic approaches, warning against the impression that good models could easily be transferred to other circumstances. He also drew attention to the fact that water is not only a very pressing issue in the mega-cities, but also in remote rural areas, which cannot master the political and economic power mega-cities have to deal with these problems.

Prof. Denis Goldberg, special adviser to South African Minister for Water Affairs and Forestry and famous for his anti-apartheid engagement, took up his keynote on "Chances and Potentials of Worldwide Cooperation in the Water sector" by tackling the issue from the perspective of how to remodel water management that served but a few to a system to serve all South Africans. At the centre was South Africa's definition of water as a human right, and the subsequent endeavour to provide each family with a basic amount of water free of charge. He saw cooperation on capacity building, the importance of consultation with the people, the intraregional cooperation within SADC (Southern African Development Community), NEPAD and AMCOW (African Ministers´ Council on Water), and good cooperation on shared rivers as key to achieving water for all in South Africa.

INPUTS ON FOCUSES
Three topics were discussed as central issues in the subsequent presentations:

- Water quality
- Water losses
- Waste water management

Taking up the issue of water quality, Dr. Francis Luck, Director of the Berlin Competence Centre for Water, reported about his centre's „Current Research Activities in Bank Filtration and Artificial Recharge Systems“. In cooperation with academic entities, bank filtration and artificial recharge systems are analyzed. (cf. presentation) The discussion showed that other cities rely as well on bank filtration schemes.

Starting on water losses, Mr Stanislaw Khramenkov of Mosvodakanal illustrated the focus with the concrete example of Moscow's efforts to reduce water losses (cf. presentation).

Mr. Abdelkarim Asa'd, former general manager of Jerusalem Water Undertaking/Palestine focussed on the managerial aspects while presenting „Key issues in water demand management leading to minimizing water losses and increasing water savings“, thereby passing the technical definition of water losses towards a more comprehensive approach, also reminding that water is one of the mayor conflict causing issues.

Mr. Boris Lesjean, Expert at the Berlin Centre of Competence for Water, gave an introduction to the waste water management focus by presenting „Visions of Advanced decentralized systems in wastewater management“. (cf. presentation)

Bringing the first day's plenary to a close, the moderator resumed that for the multiple challenges mentioned, there are no easily transferable solutions, but a yet not fully explored need for cooperation between cities with different approaches. Therefore, the evening reception, as well as the working groups and the market of opportunities on the next day were excellent opportunities for exchange and cooperation seeking.

EVENING RECEPTION BY MR HARALD WOLF, MAYOR AND SENATOR FOR ECONOMICS, LABOUR AND WOMEN´S ISSUES
The reception, taking place in the "Bärensaal", gave conference participants as well as representatives of Berlin private companies and civil society organizations active in water issues a space for informal exchange and discussions. The Mayor of berlin, Harald Wolf, called upon this unique opportunity in his opening speech.

PARALLEL EXPERT WORKSHOPS
October the 5th 2004 started with three parallel workshops on

- Water Quality
- Water Losses
- Wastewater Management

To discuss the manifold presentation from different cities on the issues, workshops were structured to along two points of interest: one, what others could learn from the specific examples, and two, how could cooperation take place.

REPORT OF THE WORKING GROUPS TO THE PLENARY
Acting as rapporteurs of their working groups, the moderators resumed the cases shown and the lessons to be learned from them.

Mr. Sven Aden reported that the Water Quality Workshop had seen a score of very interesting approaches to the issue. These were necessarily heterogenic, as conditions varied greatly. Lessons to be learned were that an integrated management approach was needed to supply sufficient drinking water to all, and that a number of variables played a role, among them financial, social and politial ones. A need for further exchange and capacity building efforts in the field were expressed.

Mr. Ulrich Nitschke of the Workshop on Waste Water Management also drew on a variety of case presentations to extract the benefits for twinning arrangements from the experiences and lessons learned of the different cities. A result of the workshop was the expressed interest to continue exchange on different aspects of wastewater management (such as experience on financial and sludge management, applied metering technologies, awareness building and funding options etc.), paying specific attention to transferable and feasible solutions.

Ms. Barbara Unger resumed the variety of cases and issues dealt with in the workshop on water losses by highlighting, as did the other groups rapporteurs, that technical issues and innovations do play a role, but that social and managerial aspects need to be taken into account to successfully lessen water losses. Awareness raising efforts, political will and motivated staff are crucial for good performance and certainly an issue for further exchange and dialogue. (cf. detailed reports of workshops)

CONCLUDING REMARKS

The concluding remarks highlighted the importance of international exchange on these matters. Prof. Goldberg reflected on the conference so far by remembering what is at stake, namely water for all. He mentioned efficient management and new ways of use as very important issues, and at the same time underlined that we are not dealing with only a technical, but also a political, economic and social issue. A case in point are Berlin's innovative and efficient technologies in an already good water situation, which can, as also Prof. Biswas had pointed out, never serve as a model for other cities with much more precarious conditions. Prof. Goldberg said that participants highly appreciated that the City of Berlin had facilitated such a meeting between water experts. Also, capacity building for all levels in the field of water was very important to continue, as water is not a commodity, but stands for life itself."

Prof. Goldberg's closing words brought the plenary to an end, leaving exchange for the following events of the conference such as the market of opportunities, the public panel debate on public-private partnership in urban water management, and the tours to different water management innovations in Berlin for the afternoon and evening and the day to come.

Dr. Jürgen Varnhorn of the Senate for Economics, Labour and Women's Issues closed the plenary part of the conference by thanking the organizers, namely his colleague Ms. Stefani Reich of the Senate for Economics, Labour and Women's Issues, and Dr. Ines Klemm from BGZ for their achievements, as well as extending thanks to the moderator, the assistants and the interpreters involved

Berlin's Water
Ludwig Pawlowski, Chief Executive for Technology of Berliner Wasserbetriebe

WATER SUPPLY

Berlin's drinking water is taken from groundwater. The sands and pebbles in the ground provide optimum natural conditions for this. The waterworks, which are located almost exclusively on Berlin's lakes, pump the raw water from different depths to the waterworks. Here the water is aerated to produce iron and manganese flocculation. The iron and manganese flocs are separated in backwashable sand filters (rapid filtration). Berlin's drinking water does not undergo any additional treatment and there is no need to chlorinate it. A precondition for this are protected zones for wells and water production areas where the need to protect the drinking water generation processes is implemented. Due to the location of the wells, Berlin has a large share of groundwater that is generated through bank filtrate (54%) or through filtration from surface water (14%). Natural groundwater recharge amounts to 32%.

WATER DISTRIBUTION – OUR CUSTOMER IS ONLINE

The Spree and Havel rivers form two natural sinks so that we are able to distribute the drinking water using three pressure zones in the relatively shallow Berlin area. The purified water pumps pump the water directly into the general distribution network from which the supply pipes are fed. For better management of supply, intermediate reservoirs with a storage capacity of the average daily need were established. The water fed directly into the network reaches all withdrawal stations. Water meters have been installed behind each household connection. Costs are calculated based on consumption. Expenses for fixing burst pipes are of special importance. While the percentage of burst pipes had increased steadily up until 1995, preventive maintenance and strategic replacement have counteracted the interruptions of supply since then. Network losses amount to less than 3%. A program for the systematic replacement of household connections made of lead has been adopted and is currently being implemented.

SEWER SYSTEM – WE TAKE BACK USED WATER -

The mixed system in Berlin's city centre, roughly covering the area surrounded by the suburban railway circle-line was established in the 19th century. A separation system is used for drainage in the urban areas expanding beyond this zone and for areas which are still being developed. Around 40,000 residents have not been connected to the sewer network yet. Wastewater sewers are being further expanded in the water production zones.

The sewage pumping stations pump the sewage produced – and the parallel rainwater discharge – into the sewage treatment plants. Around 150 pumping stations and 1000 km of pressure pipes are needed for this.

RAINWATER

Rainwater overflow occurs in the mixed system since the pumping stations and pressure pipes' drainage capacities and the treatment plants' purification capacities are limited in the case of more extensive drainage. The rehabilitation strategy for the mixed system aims to reduce the strain on water bodies by 50%. For this, the frequency of overflow is to be reduced from 25 to below 10, and the amount of overflow from currently 6 million m3/a to 3 million m3/a. In order to achieve this, the current storage volume of ponds and sewer reservoirs needs to be increased from 50,000 m3 to 200,000 m3. Rainwater treatment ponds are operated in order to feed rainwater through sewers into sensitive lakes. Additional ponds are to be built. In newly developed urban areas, the trough-infiltration/trench system is used mainly, which means that no additional contamination from the urban areas developed within the last ten years is fed into the lakes and rivers. In larger areas, the overgrown ground filters also make a decisive contribution to this effect.

WASTEWATER TREATMENT – QUALITY FOR OUR WATER BODIES

Berlin's wastewater treatment plants as a matter of principle employ biological phosphorus removal, ammonium reduction (nitrification), and nitrate reduction (denitrification). All in all, drainage values for phosphorus amount to less than 0.5 mg/l and less than 13 mg/l for nitrogen. The nitrogen degradation rate amounts to more than 85%. Due to the metal content, sewage sludge in Berlin cannot be used for long-term agricultural purposes. It is therefore used thermally – more than 40% go to the sludge incineration plant in Ruhleben.

PROSPECTS – AN ADVANTAGE FOR OUR WATER BODIES

The Tegel surface water treatment plant reduces the quantities of phosphorus that arrive at the plant together with the inflow from the Schönerlinde treatment plant, the surface and rainwater and the inflow from the Havel river to below 20µg/l. Thanks to this phosphorus removal, visibility of Tegeler See lake has increased from a few centimeters to three meters within the last 15 years. Out of all Havel lakes, Tegeler See has the highest water quality. In the future - and with a view to the EU directive on the quality of bathing water and the EU framework directive on water – the quantities of phosphorus in the treatment plant discharges need to be further reduced through membrane and floc filtration. Berlin Brandenburg's water bodies, however, will only achieve high quality in the long run if other – mainly diffuse – sources of contamination will be considerably reduced.

Water Management in Mega Cities: Current Trends and Future Perspectives
Prof. Dr. Asit K. Biswas, President of the Third World Centre for Water Management, Mexico

WATER MANAGEMENT IN MEGACITIES: CURRENT TRENDS AND FUTURE PERSPECTIVES

By
ASIT K. BISWAS, President
Third World Centre for Water Management
Mexico

Keynote Speech

INTERNATIONAL CONFERENCE ON URBAN WATERS: PROBLEMS AND SOLUTIONS WITH REGARD TO SUSTAINABILITY

Berlin, Germany
3-6 October 2004

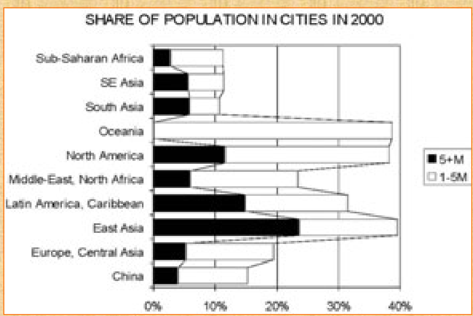
It is easier to observe the movement of stars - despite the incredible distance that separates one star from another- that it is to understand the movement of water, even though this takes place under our very eyes.

GALILEO

When you are concerned with water, experience must take precedence over theory.

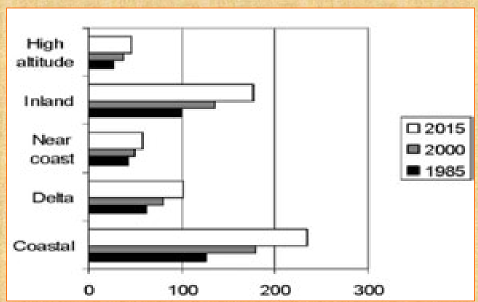
LEONARDO DA VINCI

Share of Population in Cities in 2000



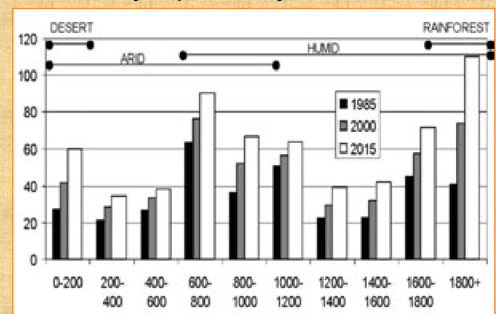
Percentage of population living in big cities (1-5M) and megacities (5+M) by r

City Population by Location



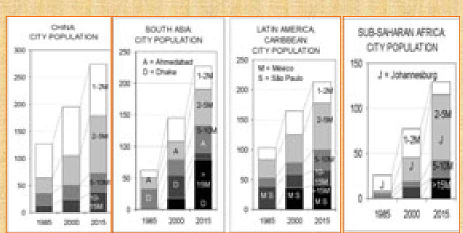
Development of megacity population by available annual rainfall and by location with respect to the sea.

City Population by Annual Rainfall

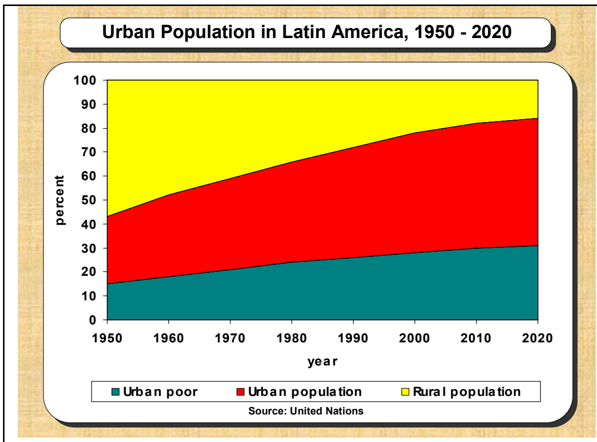


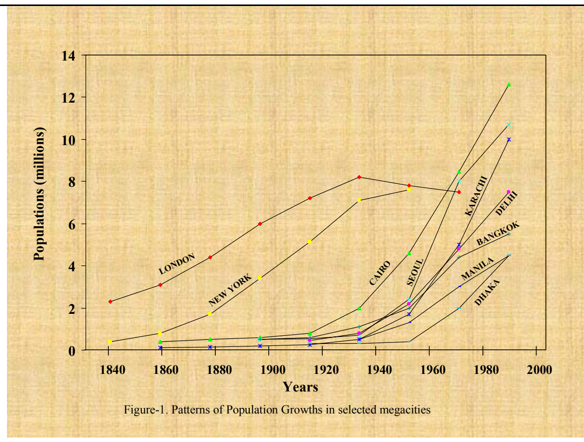
Development of megacity population by available annual rainfall and by loca with respect to the sea

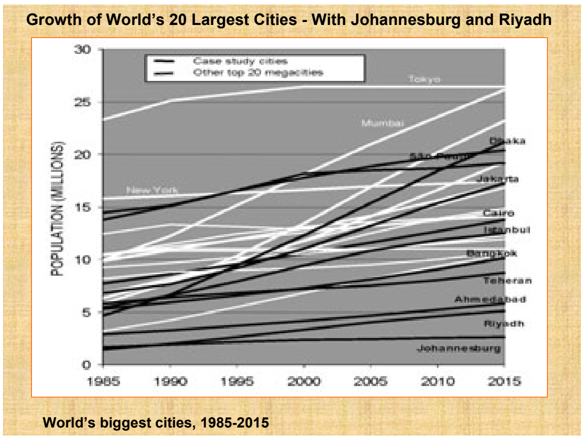
Population of World Cities by Region

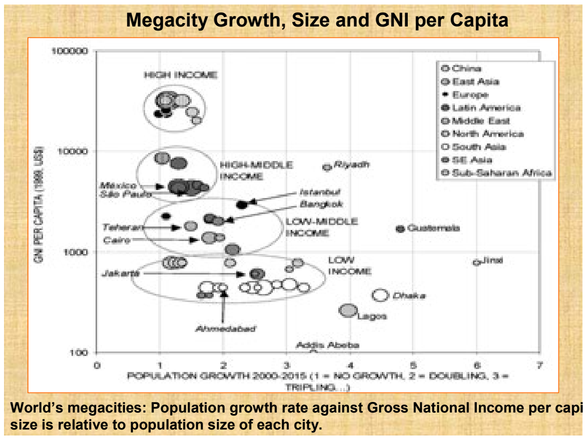


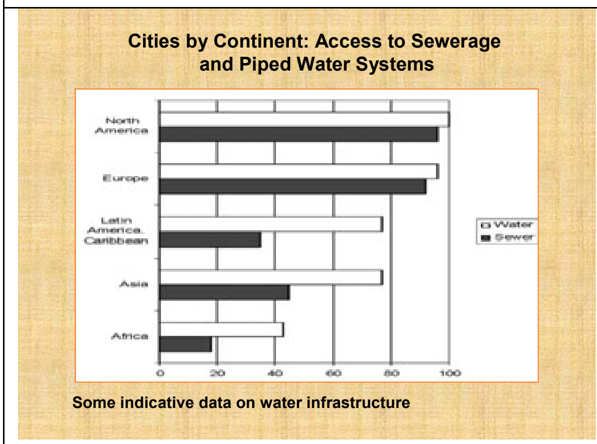
The population is classified by the size of the cities (1-2 millions,
2-5 millions, 5-10 millions, 10-15 millions and cities with more than 15 million inhabitants.

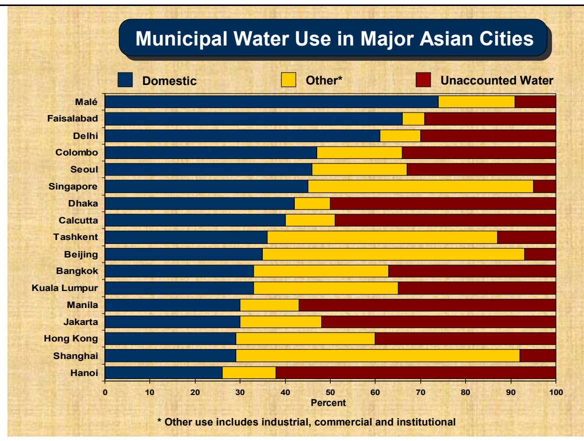

Urban Population in Latin America, 1950 - 2020
percent
year
Urban poor
Urban population
Rural population
Source: United Nations

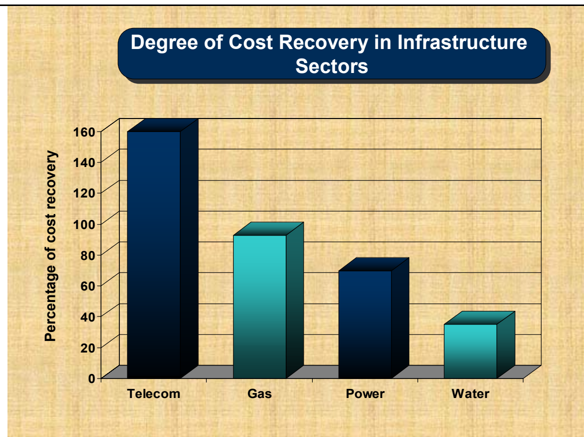

Populations (millions)
Years
LONDON
NEW YORK
CAIRO
SEOUL
KARACHI
DELHI
BANGKOK
MANILA
DHAKA
Figure-1. Patterns of Population Growths in selected megacities


Growth of World's 20 Largest Cities - With Johannesburg and Riyadh
Case study cities
Other top 20 megacities
POPULATION (MILLIONS)
Tokyo
Mumbai
New York
Dhaka
São Paulo
Jakarta
Cairo
Istanbul
Bangkok
Teheran
Ahmedabad
Riyadh
Johannesburg
World's biggest cities, 1985-2015

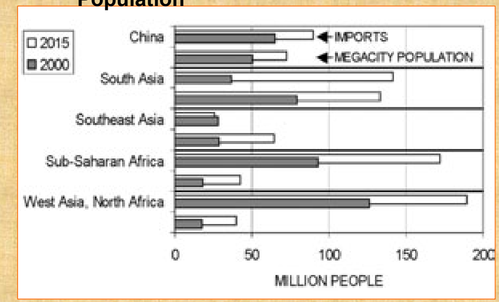

Megacity Growth, Size and GNI per Capita
GNI PER CAPITA (1999, US$)
HIGH INCOME
HIGH-MIDDLE INCOME
LOW-MIDDLE INCOME
LOW INCOME
China
East Asia
Europe
Latin America
Middle East
North America
South Asia
SE Asia
Sub-Saharan Africa
México
São Paulo
Riyadh
Istanbul
Bangkok
Teheran
Cairo
Guatemala
Jakarta
Jinxi
Dhaka
Lagos
Ahmedabad
Addis Abeba
POPULATION GROWTH 2000-2015 (1 = NO GROWTH, 2 = DOUBLING, 3 = TRIPLING...)
World's megacities: Population growth rate against Gross National Income per capi
size is relative to population size of each city.


Cities by Continent: Access to Sewerage and Piped Water Systems
North America
Europe
Latin America, Caribbean
Asia
Africa
Water
Sewer
Some indicative data on water infrastructure


Municipal Water Use in Major Asian Cities
Domestic
Other*
Unaccounted Water
Malé
Faisalabad
Delhi
Colombo
Seoul
Singapore
Dhaka
Calcutta
Tashkent
Beijing
Bangkok
Kuala Lumpur
Manila
Jakarta
Hong Kong
Shanghai
Hanoi
Percent
* Other use includes industrial, commercial and institutional

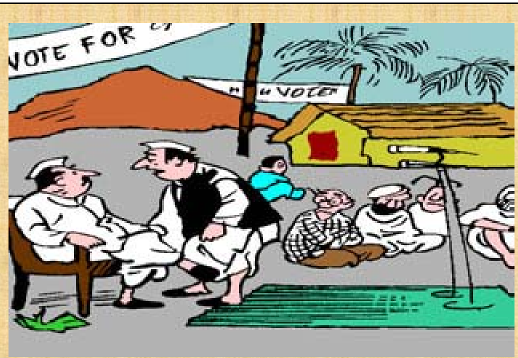

Degree of Cost Recovery in Infrastructure Sectors
Percentage of cost recovery
Telecom
Gas
Power
Water

Food Imports VS Megacity Population

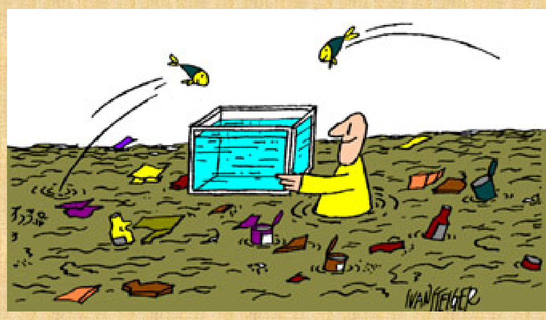


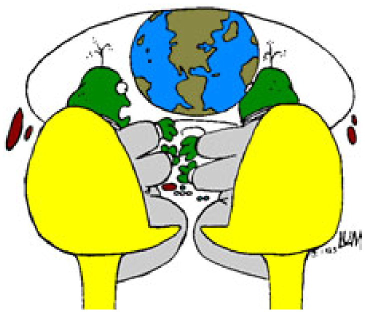
Comparison of megacity population and the cereal net imports calculated to correspond the number of people to which the food is imported.

Remember, when we were his age we too jumped with joy when we read the item about complete eradication of poverty?



No, I won't advise you to promise them water. Promise something simple.





"Remember. . .don't drink the water!"

It is not the strongest species that survive, nor the most intelligent, but the ones most responsive to change

Charles Darwin

Water Sector Cooperation: A South African Perspective
Denis Goldberg, Special Adviser to Ms Buyelwa P. Sonjica, Minister of Water Affairs and Forestry, South Africa

Ten years ago this year South Africa established its first democratic government. Among other things this presented the opportunity to start addressing the gross inequality of access to water inherited from the Apartheid era. Some 16 million people out of a population of 40 million had no access to clean drinking water. These are notes for a discussion of cooperation in the South Africa water sector during 10 years of democracy, pointing to future areas of cooperation.

The Department of Water Affairs and Forestry needed to restructure itself to be able to meet the needs of the whole population. The assistance of advisers, provided mainly from the EU multilaterally and bilaterally, has been an essential element in this process. Experts were needed for implementing rural water service that required the use of groundwater on an unprecedented scale. Hydrologists from Cuba provided support for this activity.

Capacity building, especially at local government level where water services are implemented still requires outside help although there has been much improvement. The sector as a whole needs the development of training institutions and cooperation with institutions in other countries at every level.

The Free Basic Water policy was a unique contribution to the dilemma of water as a human right and therefore a common good on the one hand and water supply as the sale of an economic good as a commodity on the other hand. Up to 6 kilolitres of water per household is to be provided free of charge. Each local authority is required to determine the exact amount and to whom it will provide free water to ensure the right to sufficient water enshrined in the Constitution. In this policy South Africa leads the way.

Consultation and cooperation between institutions to provide access to drinking water was seen as the key to the rapid provision of these services. The preferred solution is that of cooperation between government institutions at national, provincial and local levels followed by Public Public Partnerships. These partnerships between local government and parastatal water utilities have a long history in South Africa and bring pools of technical and financial skills into the public sector. These parastatal bodies are established by Act of parliament and are required to report to the Minister while their annual reports are tabled in parliament.

Public Private Partnerships are the least preferred solution, but a local authority may enter into such a contract provided that the infrastructure remains the property of local government. This is the essential definition of a concession agreement for a fixed period and subject to strict guidelines being adhered to. The local government must retain the right to set tariffs for the water supplied. The Free Basic Water Policy must be implemented, and the local government must have the capacity to monitor the concessionaire's performance and insist upon compliance with the agreement and the public partner must be able to cancel the contract.

Private sector involvement occurs in many other ways and it will continue to be involved in water service provision. Consider for example the role of consulting engineers, construction companies, accounting firms that may be contracted to monitor the project on behalf of local governments the private sector provides finance through taking up municipal bonds, loans and other financial instruments.

Two cases of partnership were discussed in some detail. The first was the Greater Nelspruit Utility Company (GNUC) which is a Public Private Partnership with a UK/Dutch Utility, Cascal, formerly Biwater, as the concessionaire. Despite a poor record of communication between GNUC and the population a small town of 24000 people has been able to quickly extend its water supply service to 230000 people very rapidly. Wages paid to workers are higher than before, training has been improved, infrastructure has been built with bank credits that were inaccessible to the Municipality on its own. The Free Basic Water Policy has been fully implemented, but the concessionaire has been unable to persuade householders to pay for the water they use. Only about 22% of those who can afford to pay do in fact pay causing endless problems of renegotiation between the Municipality and GNUC's principals.

The second case is that of Johannesburg Water which is a utility company wholly owned by the Johannesburg Metropolitan Municipality. All its water assets were transferred to the wholly owned utility company to remove its general operations from the equivalent of "exchequer funding" and to operate it as a trading organisation. As a nominally independent company it will be able to raise finances for infrastructure other than from taxes and transfers from the national Treasury. Finance institutions need the certainty of contracts that will not be changed from year to year by elected local governments. Johannesburg also had to incorporate the infrastructure from some thirteen other instances such as surrounding local governments, Bantustan authorities and other institutions. There were no complete inventories of assets and their location, their age and technical specifications. An international water company was engaged to advise them on integrating these installations into a single efficient utility. There has never been any intention to sell shares in the utility and the Johannesburg Metropolitan Council wants the utility as a cash cow to enable it to either reduce the municipal rates (taxes) or to have an income to enable it to do more for the historically disadvantaged communities.

In the field of water resource management a strategy document has recently been published by the Government. This strategy was three years in the making and includes a comprehensive study of water resources. The successive drafts were publicised and interested groups and individuals were invited to comment. The Government has only a few weeks ago approved the Water Ministry's National Water Resource Strategy document. This is a very comprehensive document that provides a survey of our present infrastructure, of infrastructure potential and ways forward to greater involvement of people in Catchment Management Agencies that will be involved in planning and management of water resources in each of the 19 primary catchments identified by our studies. This concept is similar to the water user associations that are being created to manage the use of water at a micro level to try to ensure democratic participation.

Legislation on water polluting activities is an essential tool that functions on the basis of the polluter pays. The intention is of course to compel water users to build into their costs the need to ensure that water sources are not polluted by using non-polluting technologies and cleaning up water by appropriate methods before discharging water into water courses.

Mining creates a major problem when mines are worked out and pumping stops. Research into the removal of harmful minerals is essential to bring the costs of processing down. It is not only the water that goes to waste. It is the pollution of surface and underground water sources that is the major problem.

Waste treatment plants cannot deal with the increased flows from the million and a half newly built houses. This has resulted in the discharge of untreated human waste into rivers creating a major expansion of health hazards. This is a consequence of lack of finances and inadequate coordination between government departments and between levels of government inn their haste to provide homes for the homeless.

International cooperation is an important component of South African Government policy. President Mbeki has made the theme of African Renaissance a cornerstone of his presidency.
NEPAD – New Economic Policy for African Development - is a cornerstone of foreign policy since South Africa sees the peaceful development of Africa as an essential component of its own freedom. Assistance for development must be given because we can give it in the sense of sharing what we have. It is the right thing to do! It is also the right thing to do because it is less costly to create the conditions for peace than to send in armies and aid to restore the peace! We are responsible for each other!

The African Ministers Council on Water is the main vehicle for Cooperation between South Africa and other countries on the African continent. AMCOW was formally established in 2002 at the World Summit on Sustainable Development held in Johannesburg. Despite some administrative hurdles AMCOW has played a significant role in enabling African countries to coordinate their views and understanding of numerous issues.

This emphasis on continental development is relevant to the water sector because South Africa shares rivers with its neighbours. All the countries of the Southern African region subscribe to the SADC principles that shared rivers provide the opportunity for peaceful cooperation by mutual agreement. Joint Councils with each state involved in a particular river system having equal membership manage the systems for mutual benefit. One example is the Inkomaputo Agreement involving South Africa, Swaziland and Maputo. Similarly there are accords with Zimbabwe, Lesotho, Namibia and Botswana either fully developed or in the process of being developed.

The Lesotho Highlands Water Project that gathers the rainfall of Lesotho and puts it to use in Lesotho and South Africa is the best known. Lesotho exports some of its white gold in the form of water and also uses it in the form of hydropower that has provided the energy for a remarkable growth in industry in that small, mountainous, land-locked country.

Lesotho now has an assured water supply evened out by the storage facilities and a reliable source of hydro electricity on a previously undreamed of scale. South Africa has an assured water supply for its Vaal River basin, the industrial and mining heartland of Gauteng Province and South Africa. Some 20 per cent of South Africa's population lives in this Province that produces some 40 per cent of the gross national product. Without South Africa's off take of water it would not have been possible to raise the international finance for the project. South Africa is zealous in ensuring that its international obligations are met even at the expense of water restrictions inside South Africa itself during particularly harsh drought conditions.

The Lesotho Highlands Water Project has demonstrated once again the importance of large dams to save what water an arid region does receive and to use it judiciously for the benefit of many people. The economy of Lesotho has benefited enormously to the point where the electricity generating capacity built into the first phase of the project has been already found to be too small. The water available to farmers in the lowlands needs augmentation and Maseru, the capital city, has already grown beyond the planned capacity provided for it under the first phase of the project.

The World Commission on Large Dams was chaired by South Africa's first new Water Minister after 1994, Professor Kader Asmal. It is good that the social consequences of such structures have been highlighted so that the costs of providing proper living conditions for people who have to move after long and detailed consultation can be built into the project finances. South Africa needs Large Dams and it is fortunate that the Report of the Commission has a chapter on the processes that should be followed before one begins to build a large dam. South Africa needs to build dams to even out our water supplies.

The World Summit on Sustainable Development (WSSD), Johannesburg 2002, followed up of the Rio Earth Summit 10 years previously, and saw the less developed countries taking the lead to compel the richer nations to accept the need for targets to be stated in measurable terms. Relevant for this paper are the targets to halve poverty by the year 2015, and to halve the number of those without to access to clean water and to basic sanitation by the same year. South Africa plans to achieve access to these needs by all the population by 2008 for water and 2010 for basic sanitation. The speed with which South Africa seeks to achieve these targets is a measure of the seriousness with which it sees that water, health and a reasonable standard of living are human rights to be achieved as quickly as possible.

In conclusion one sees that there is no end to the problems that need to be solved and there is no end to the possibilities of cooperation in every aspect of the water sector. This outline was intended to be brief, but it always necessary not to oversimplify and to clear up common misconceptions in the minds of people in developed countries about the complexity of the situation in developing countries.

Current Research Activities in Artificial Recharge Systems

Dr. Francis Luck, Berlin Centre of Competence for Water gGmbH, Germany

The city of Berlin is using bank filtered surface water and artificially recharged water for drinking water production (see Fig.1). As far as some hydrological trends and development of anthropogenic pollutants may threat the future of the water resource in Berlin, it is important to measure the capacity of ground filtration to answer to such developments, and to secure the use of these systems through the development of the most appropriate practices and the related technologies. This was an obvious reason to initiate a multidisciplinary cooperation project at the Berlin Centre of Competence for Water named Natural and Artificial Systems for Recharge and Infiltration (NASRI). It will focus, for example on questions of the emergence and removal of pharmaceutical residues during bank filtration. The fate and the destination of other specific trace substances as well as of bacteria and viruses are other objectives of the research programme. Several institutions from Universities, the German Federal Environmental Agency and the Centre of Competence for Water are focusing their expertise in six workgroups connected with each other.

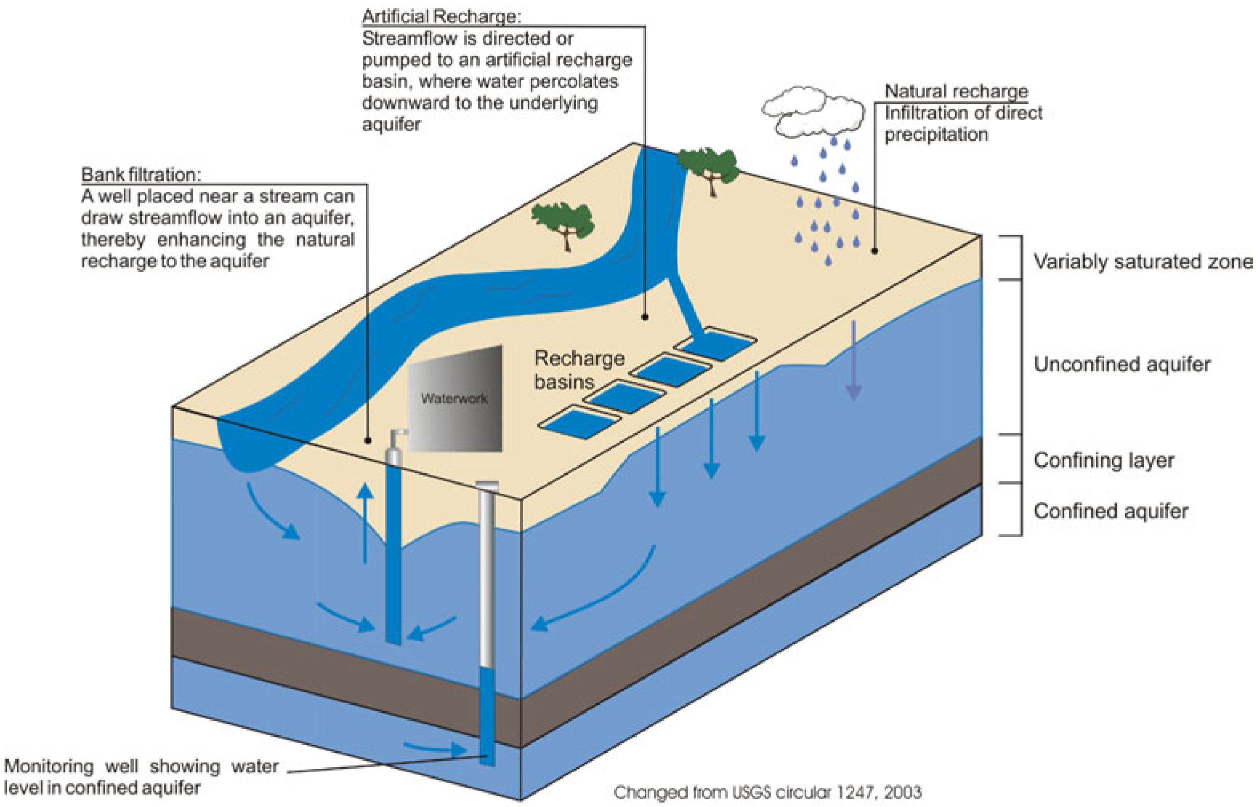


Figure 1: Artificial recharge systems (bank filtration and artificial recharge).

The underground passage during bank filtration is a natural cleaning process which is beneficial for the drinking water production. It starts in the clogging layer and continues in the aquifer sands. The natural attenuation of contaminants includes the elimination of suspended solids, particles, biodegradable compounds, bacteria, viruses, parasites as well as the partial elimination of adsorbable compounds. The removal is caused by the interaction of biotic and abiotic processes such as physical filtration, biodegradation, adsorption, chemical precipitation and redox reactions. The advantages clearly dominate over possible disadvantages such as the increase of iron, manganese, hydrogen sulphide or ammonium, which can easily be removed in the waterworks. The clogging layer is generally more biologically active than the aquifer, degradation rates and adsorption capacities are higher than in the aquifer. Over the years, several transects (see Fig.2) have been installed at representative locations in Berlin, reaching from the lake or artificial recharge pond to a production well parallel to the flow direction. These transects contain a number of observation wells in various depths, usually one below the lake, some between lake and production well and some beyond the well. Recent investigations focus on two bank filtration field sites and one artificial recharge pond. Since May 2002, surface water, observation wells and abstraction wells have been sampled monthly and analysed for a large set of parameters including stable isotopes, rare earth elements, standard cations, anions, drug residues and related polar contaminants, organic substances (differentiated AOX-analyses and trace organics e.g. x-ray contrast media, bacteriostatica, naphthalinsulfonates), cyanobacterial toxins, bacteria and viral pathogens at laboratories of several Berlin Institutes.

First results after two year sampling and analyses can be presented, some examples are the following: Geochemistry: depending on the geochemical conditions during the flow path, variations in degradations can be seen. The evaluation of the redox conditions shows that redox successions proceed with depth rather than only in flow direction. In addition, the redox zoning as characterised by the appearance or disappearance of redox sensitive species, is very transient. This poses a challenge for the interpretation of data from redox sensitive substances.

Pharmaceuticals: the blood lipid regulator bezafibrate, and the analgesic indometacine were significantly removed during the infiltration, only traces of them sometimes reach the abstraction well. The analgesics diclofenac and propyphenazone were less efficiently removed during the ground passage. Only five of 36 antibiotics were detected in surface water and all were efficiently removed during bank filtration.

Organic substances: The reductive system allows a dehalogenation of the AOI. In contrast, Iopromide (one x-ray contrast media) is reduced by > 90 % in predominantly oxic as well as in anoxic conditions. Laboratory experiments (batch and column experiments) are in progress to help to understand the key processes of compounds from which we do not know exactly their behaviour in the aquatic environment.

CONCLUSIONS

Bank filtration used as an additional treatment step is a very successful story in Berlin. Nevertheless, depending on the geochemical system and occurrence of substances with unknown behaviour in the aquatic system, special emphasis should be placed on scientific investigation of degradation rates dependent on the hydraulic system. The results of the tracer studies can be used to interpret the fate and behaviour of potential contaminants (e.g. drug residues, organic pollutants etc) especially if combined with lab experiments which are used to define adsorption, microbial degradation or redox sensitivity of sewage water borne substances. Models and guidelines, developed on the base of these studies, will be transferred worldwide to new places. They can be used as a tool for water supply companies which would like to start with this technique.

Acknowledgements: We would like to thank Veolia Water and the Berliner Wasserbetriebe for financial support of this research project.

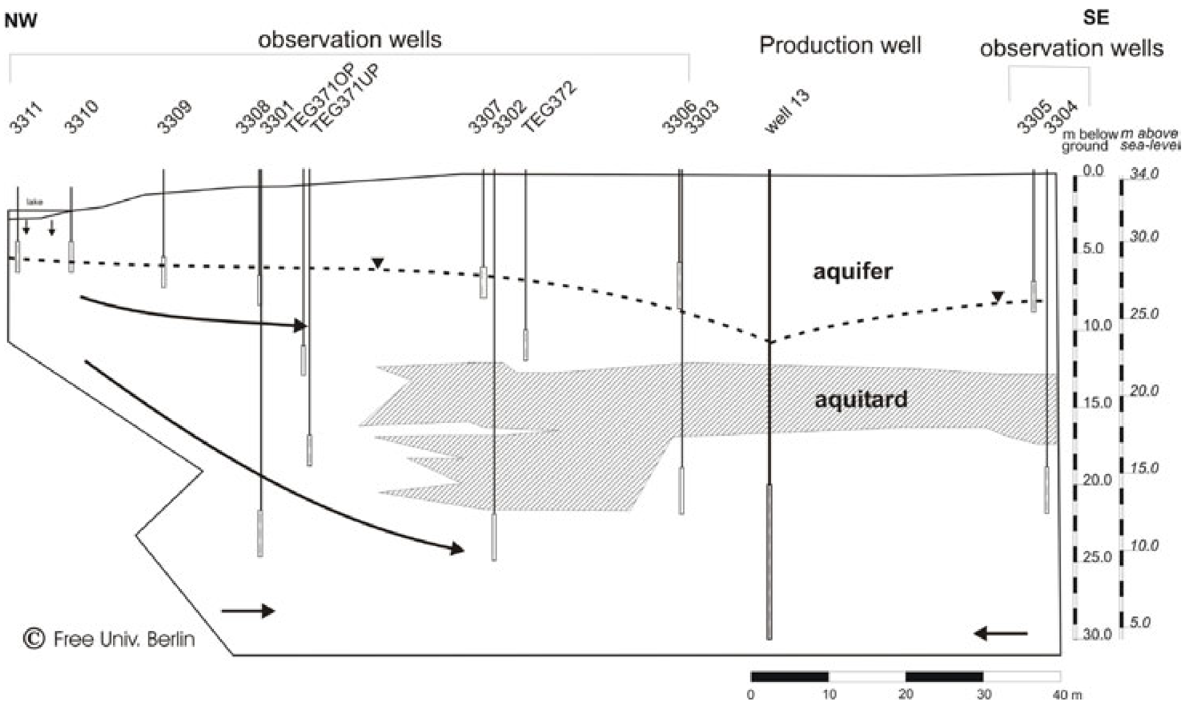


Figure 2: Schematic sketch of a field site with different observation wells in different depths.

Strategies of Managing Water Losses in the Moscow Water Supply System

Stanislaw W. Khramenkov, General Director of Mosvodakanal, Moscow, Russia

An economical utilization of the available water resources in the economic activity is a fundamental task of humankind. Water is necessary to each person for nutrition, living and working. It is consumed in large quantity by: industry, power engineering, transport, agriculture.

Russia has enormous water resources, particularly those of fresh water. That includes a yearly renewed river drain and age-long reserves in lakes, glaciers and swamps. 20% of the worldwide resources of fresh water are concentrated in the Baykal Lake only. In the national economy of the country, basically, river drain is used. It comprises 4700 cubic kilometres per year (mean sea level). The Volga only already provides 250 cubic kilometres on average per year.

With production and use of produced goods of any kind, a certain amount of losses is inevitable, both regarding the raw material and the product itself. This also applies to water - the process of production and transportation of drinking water to the consumer is accompanied by certain losses - both of initial water (raw material) and drinking water (product). In industry (production of this or that kind of product), norms of losses exist at each step, regulated through calculation procedures. For the production of drinking water respective affirmed norms do not exist.

In Russia, water demands for a long time have been determined by high-level norms. As result, a deficit of water occurred in several cities. This did not belong to Moscow so far - deficits were not stated. Up to 1985 the water consumption grew by 2-3% per year. The state policy was directed toward an increase in the volumes of the production of water, now and then without taking into account the ecological consequences for the environment. Water always had a low value and, in principle, did not be a good. Further, in many branches of the national economy, particularly in housing industry, water is not spent economically. A large part of water gets lost in the municipal water supply systems.

Prior to passing to the topic of estimation and analysis of losses, it is necessary to determine what which is understood under water losses. By term the overall losses of water resources connected with the operation of water supply systems are to be understood as the difference between the quantity of water gathered from the water sources and the volume of the water, realised by the consumers.

Overall water losses include losses on technological requirements, consisting of water losses (raw material) in the process of extraction, production and transportation to the consumer, as well as losses at consumers and unsold water. Technological losses, as a rule, are considered in the original/prime costs of production and are of normative value, they are well known to the experts, can be controlled easily and their management does not present special complexities.

Another part of water losses relates to the consumer group. Losses at the consumer are counted as losses as well, despite the fact that they are paid, but in view of low water prices hey are not reduced. The main reasons for "losses" of paid water are as follows:

- leakages at sanitary facilities;
- leakage of warm water due to low temperature provided;
- high pressure at the consumer's water taps;
- low water prices.

The "Unpaid" water is the difference between overall delivery volume of water by the water stations and the volume of water, measured by the water meters installed at the consumers.
"Unpaid" water includes the following components of losses:

- Water consumption for fire prevention needs; cleaning of reservoirs, the irrigation of streets, the washing of mains;
- visible leakages from water supply mains (from wells or ground);
- unnoticed leakages from water supply mains (such leakages are located using special equipment);
- obvious water losses, caused by illegal connection to pipes (stealing of water);
- consumption of water, which is not measured (margin of error in measurement).
- measuring errors at the water meters.

It is completely obvious, that unpaid water directly effects to the original/prime costs for water, and the higher its size, the higher the original/prime costs.

Thus, management decisions for struggle against water leakages may really decrease the losses, without any effects on the efficiency of work or the standards of consumer services. The evaluation of the losses is to be made on the basis of a water balance.

With regard to the deterioration of the water supply systems, new leakages and disaster damages occur. In view of this, Mosvodokanal introduced a system of water losses control and management, including the following:

- Management & control of water pipelines and capital investments;
- Strategic planning of activities regarding modernisation of water supply mains
- Control of pressure/compensation in the water supply mains (the aim is to increase or decrease the pressure without allowing sharp jumps);
- Control of unnoticed leakages and their localisation.

At the present time the lengths of the Moscow pipelines in water pipe mains is about 11000 km, among them 72% compose steel pipes. Up to now, more than 4200 kilometres (50%) of the Water pipeline have already exceeded their service life time. Evaluation Calculations showed that if the pace of renewal of water pipelines in the city mains remains at the previous level, then in 2020 more than 72% of the pipelines will already be amortised.

It should be noted that in spite of the stabilization of the yearly number of malfunctions at water pipelines (emergency cases/damages or excavations) in municipal water pipeline mains reached in recent years, the average value of the failure rate is about 0,5 damages per year on 1 km of pipes (in Western Europe the mean value of the failure rate it is approximately 0,21 damages per km only).

Today, the company Mosvodokanal passes from the task of stabilisation of damages at pipelines towards the task of its step-by-step reduction. Great significance is given to a well readjusted automated system of control of the operation of the pipeline mains and to the optimization of strategy of their regeneration and renewal. For this purpose electronic data bases are set up, automated information technology systems (AITS) are developed and installed in the Moscow water pipeline mains, being the basis for a geo-information system to be developed.

CONTROL OF PRESSURE

For the stabilisation and maintenance of the required excess pressure in Moscow water pipelines the activities are focussed on the following:

- Configuration of an hourly forecast of water consumption in the city and set-up of a suitable working schedule for the pumping stations of the 2nd and 3rd elevation/lift;
- Zoning of the city water distribution mains through installation of pressure modulators;
- Control of the mains working scheme through displays of manometers and control of staff in the main dispatcher centre;
- Set up of a hydraulic model of the distribution network in the city and its utilization for daily work;
- Application of instruments of telemechanics and transformation frequency for intensification of works of the pumping stations of the 2nd and 3rd elevation/lift;

SET UP OF A HYDRAULIC MODEL OF THE WATER PIPELINE MAINS

In 1994, Mosvodokanal started activities for establishing an information system (hydraulic model) for the analysis of work of the water pipeline mains in Moscow.

Today, an accounting scheme of the main line and distribution water pipeline mains is elaborated and identified for the Moscow districts of Tushino, Mitino, Strogino. The data base contains information about the structure of the main line and city district water pipeline mains, the local stock of regulation elements, diameters and lengths of parts of the mains, Size of the knots, numbers of inflow into the water pipelines as well as geodetic remarks.

Calculations, realised using the computer models set up, allows to make an analysis of the work of water-conducting systems with different regimes of the water consumption

The results of this analysis allow:

- to determine the areas of excess pressure;
- to determine the zones of a possible change in flows or speeds in case of emergency and planned turning offs of one or another section in the water pipeline mains
- to include into the plans of cleaning parts of the pipeline mains, which work with low speed;
- determine stagnant sections for the purpose of conducting additional quality control of the water

- to take measures for the normalization of the work of main and quarterly water pipeline mains in the separate city districts

In the first stage, the data-measuring system is used for the analysis of the working scheme of the water pipeline mains, subsequently, in proportion to deployment of the stationary means of measurement and automation of the process of collection and information processing, is assumed the transfer of system into the regime of a guidebook

The conducted measures contributed not only to reduction in the accident rate in the city, but also as consequence to a reduction in the quantity of leakages of the mains.

UNNOTICED LEAKAGES

Yearly planned work on the detection of concealed leaks on water pipeline mains is conducted according to a specific plan. Per year, up to 60 km pipelines are inspected with the assistance of special equipment "Water losses analysis". The volume of losses comprises, on average, 1,7% of the overall delivery volume of water. The greatest quantity of concealed leakages is observed in little pipelines with small diameter. The accuracy of indications in this case comprises more than 90%. Over the long term it is planned to increase the volume of inspections to 200-300 km per year.

CONTROL OF INDICATIONS OF CONSUMER´S WATER METERS

Calculations for the services executed by Mosvodokanal regarding water supply and water disposal are made according to the actual data and on the basis of the indications given by water meters. 316.000 water meters are installed in the city and more than 450 thousand in the apartments. Mechanical counters prevail. Measuring errors of the instruments are ±2%; the between-check interval is 6 years.

CONCLUSION

The conducted investigations and the calculated estimate of the magnitudes of the water losses make allow it to draw the conclusion that the volume of the unpaid water on the Moscow water pipelines composes 8,8% of its supply into the city mains with following structural components:

- water consumption for disinfection, washing of reservoirs and leakage of them - 0,55% of the total volume of water, provided to the city mains;
- visible water leakages and consumption for operation in case of emergencies or damages in the water pipeline mains - 0,05% of the total volume of water, provided to the city mains;
- water consumption for fire-prevention needs - 1,5% of the total volume of water, provided to the city mains;
- measuring errors of the ultrasonic flow meters during measurements of water supply into the city pipeline mains - 3,0%;
- measuring errors of the water meters installed at the consumers, - 2% (on the passport of measuring meters);
- unnoticed leakages from the pipeline mains, arbitrary water-use etc. - 81,93 thousand cubic meters per day or 1,7% of the overall amount of water, provided to the city mains.

On the basis of the presented figures the conclusion should be drawn that the economic expediency of avoiding water losses consists of the decrease of the volumes of the removal of water from natural sources, and, correspondingly, the decrease of the discharges of water into the canalization.

Besides the technical solutions, directed toward the realization of control of the water losses, it is necessary to ensure conducting a state policy in the following areas:

- the legislative regulation of payment for the removal of water and discharge into the environment;
- the regulation of tariffs on the reduction of production costs in the water supply and distribution companies;
- the mobilization of investments through the building of main systems for reduction of losses in the distribution mains;
- a reduction in environmental burdens.

The volume of unpaid water as percentage of the overall delivery volume functions as indicator of effectiveness of the water supply system.

Natural resources more and more become scarcity; the water sources are given great significance, thus resulting in an increase in investments.

Key Issues in Water Demand Management Leading to Minimizing Water Losses and Increasing Water Savings

Abdelkarim Asa'd, Former General Manager of Jerusalem Water Undertaking Management Consultant, Palestine

Water is a scarce and precious natural resource in Palestine. Large investments are required due to geographical, topographic, and hydro geological reasons to make this limited resource available to fulfill public requirements. The intention from writing this paper and the presentation delivered in the Berlin 2004, water conference was to provide the managers of water utilities with practical basic knowledge in planning and implementing water demand management activities on the national level as well as on the utility level.

The most prominent defect of the water sector in Palestine is its obsolete and inefficient infrastructure built more than 50 years ago without any compliance to technical specifications. In addition, the scarcity of financial and human resources and the lack of authority over the infrastructure (Due to occupation by Israel), have prevented the proper maintenance and expansion of the water system to reach the uncovered areas (about 50 % of Palestine is not serviced with drinking water) and to meet the demands of an ever increasing population.

The deteriorated state of the water infrastructure in Palestine, and the hindrances that were put on its development, are best reflected in the huge losses the Palestinian water sector suffers annually due to the high percentage of unaccounted-for-water (U-f-W); which amounts to as high as 50% of the total water supplied.

Problems such as U-f-W which is caused by the inefficiency of the existing waterworks' components starting at the source and ending with the consumer, compelled us to focus on coming up with the right solutions in order to move closer to our ultimate goal of fulfilling the water demand by using the available resources in the best and most efficient manner.

The following are the recommended steps for conducting a sound water demand management plan:

CONDUCT A STRATEGIC PLAN

- Define the area, time frame, and assumptions
- Prepare inventory of the sources, distribution, and metering systems
- Collect, Sort, and analyze available information such as reports, studies, research, and master plans
- Identify ongoing rehabilitation projects, awareness campaigns, and water saving projects
- Define your strategies and action plan
- Conduct Cost-Benefit analyses
- Prepare conceptual designs and project proposals
- Monitor, modify, measure, and evaluate implemented projects

Each of the aforementioned steps must be studied and analyzed thoroughly in order to be able to achieve your goals.

Water loss reduction can be achieved and measured through:

1. Physical Activities: Enhance the efficiency of production and distribution systems
2. Economic incentives: Demand management oriented tariffs
3. Conservation Programs: A combination of technical, socio-economic, and regulatory activitie
4. Benchmarking: "If you can measure it you can manage it"

Accurate measurement through the use of financial and operational indicators is an important tool that makes you able to measure existing situation, achievements and you will be able to compare your achievements to other achievements world wide.

The following are indicators that can be used:

Financial indicators

- Ratio of maintenance cost per m3 to average cost per m3
- Cost of public awareness campaigns per consumer
- Traditional Performance Indicators
- Volume lost per length of mains per unit time
- Volume lost per property per unit of time
- Volume lost per service connection per unit of time
- Volume lost per length of system per unit time
- Percent of volume lost from input volume
- Percent of metered consumers in the system
- Percent of re-used treated wastewater in industry and in irrigation

None Traditional Indicator:

- The Infrastructure Leakage Index (ILI):
- TIRL/UARL
- “Is the ratio of the Technical Indicator for Real Losses (TIRL) to the value of Unavoidable Annual Real Losses (UARL), calculated for current pressures and continuity of supply”

Source: Corrected final version dated 26.01.2000; A Review of Performance Indicators for Real Losses from Water Supply Systems A.O Lambert1, Timothy.G. Brown2 , M. Takizawa3 , D. Weimer4

Berliner Wasserbetriebe (Neue Jüdenstr. 2)

14:15	'Market of Opportunities' Exposition of Institutions and Enterprises from Berlin and Partner Cities on Water Issues, Presentations, Discussions, Cooperation and Networking

European Academy (Bismarckallee 46/48)

18:00	Dinner Film 'Thirsty Planet' (Deutsche Welle)
19:00	Evening Event: Panel Discussion 'Chances and Examples of Public Private Partnership in the Water Sector' Volkmar Strauch, Secretary of State, Senate Department for Economics, Labour and Women's Issues (Welcome Address) Dr. Annette van Edig, Water Advisor to the Federal German Ministry for Economic Cooperation and Development (BMZ) Prof. Dr. Asit K. Biswas, President of the Third World Centre for Water Management Prof. Dr. hc. Dr. Ing. Denis Goldberg, Advisor to the Ministry of Water Affairs and Forestry, Republic of South Africa, Director of Community H.E.A.R.T. Dieter Ernst, Chairman of the Board of Berlinwasser International Reinhold Hüls, Managing Director Veolia Water Germany Dr. Eckart D. Stratenschulte, European Academy, Moderator
21:45	Discussion and get together

Wednesday, 06 October 2004

Institutions and Enterprises in Berlin and Brandenburg

08:45	On-site Visits in three Groups Tour (A): Innovative Water Concepts: Process- und Rainwater-Management Visit of successful examples to substitute drinking water by process- or rainwater in buildings throughout Berlin (e.g. Adlershof), Marco Schmidt Tour (B): New Decentralised Concepts of Wastewater Treatment Visit of a large-scale test (pilot project) for separation and separate treatment of substances in sanitary systems in buildings (Stahnsdorf), Dr. Anton Peter-Fröhlich Tour (C): Concepts of Wastewater Treatment and Reuse Aspects Visit of examples to implement innovative technological solutions into practice in a sewage treatment plant (Waßmannsdorf), Mr. Prenzel, Christoph Sahlmann, Dr. Klaus Möller
13:00	Lunch
14:00	Parting Words End of the Conference

Vision of Advanced Decentralised Systems in Wastewater Management
Boris Lesjean, Berlin Centre of Competence for Water gGmbH, Germany

The Millennium Development Goals identified by the United Nations at the world summit on sustainable development hold in September 2002 in Johannesburg includes the reduction by half of persons having no access to sanitation or drinking water by 2015. In order to achieve these ambitious but necessary goals, new resource management strategies will have to be developed and implemented, and new water resources will have to be identified. Furthermore, huge investments will be required to build the required infrastructure to collect and treat waste waters. With the onset of global sustainable development, it becomes also obvious that wise management of water should be integrated in a holistic approach including the careful management of other commodities such as energy (limited resource of oil, greenhouse effect, climate change, etc) and fertilisers (nitrogen, phosphorus, trace elements, etc). In this context, we will show that novel advanced decentralised sanitation systems could represent viable alternatives to help achieving the Millennium Development Goals while complying with the principles of sustainable development of water, but also energy and fertilisers.

SIGNIFICANCE AND POTENTIAL OF DECENTRALISED SANITATION
Recent statistics show, that countries like India exhibit a connection rate to sewer of only 20% of the population. Whereas in industrial nations like the USA, 25% of the population´s wastewater is treated with decentral or semi-central equipment. A country like Denmark achieves close to 100% of wastewater sanitation while resorting to decentralised treatment for around 10% of the population. Such figures demonstrate the needs, significance and potential of decentralized or semi-central sanitation strategies.

The economical interest of remote sanitation concepts can be encapsulated in one well-known observation: in conventional and central sanitation schemes, the capital expenditure related to the construction of the sewer network amounts usually from 70 up to 90% of the total project costs. Decentral or semi-central sanitation system may avoid part of these expenditures, and from then on may become economically interesting, should the additional capital and operation costs of the scale-down wastewater treatment can be controlled.

In addition, other technical advantages of remote sanitation schemes reside in the following facts, which can also results in savings and/or revenues when compared with central schemes:
easier implementation of water or nutrients recovery and reuse at local scale
easier handling of biosolids (no run-off = less biosolids, no industry = no toxicity and greater reuse possibility)

However, the World Health Organisation guidelines stipulate that “without supplementary disinfection, conventional processes (stabilisation ponds, reed beds / plant filters, soil filters, activated sludge, sequenced batch reactors, rotating biological contactors, biofilters / trickling filters) cannot produce an effluent that complies with guidelines for unrestricted irrigation”. Therefore the reuse of treated water is limited by actual technologies, and advanced treatment technologies are required for improved performance. In addition, robust intensive treatment systems would be useful for the decentralised sanitation of densely urbanised areas which are not sewered. Despite the end-of-pipe treatment technologies, the recent idea of “Ecological Sanitation” consists in rethinking the entire resource cycle while dividing at the source the different types water fluxes in order to optimise recovery or saving of water, nutrients and energy.

The present article reviews briefly three novel concepts for decentralised sanitation strategies, namely the technology of membrane bioreactor, the hybrid systems decentralized / semi-central, and the ecological sanitation concept, as well as research and demonstration projects led by the Berlin Centre of Competence for Water on these issues.

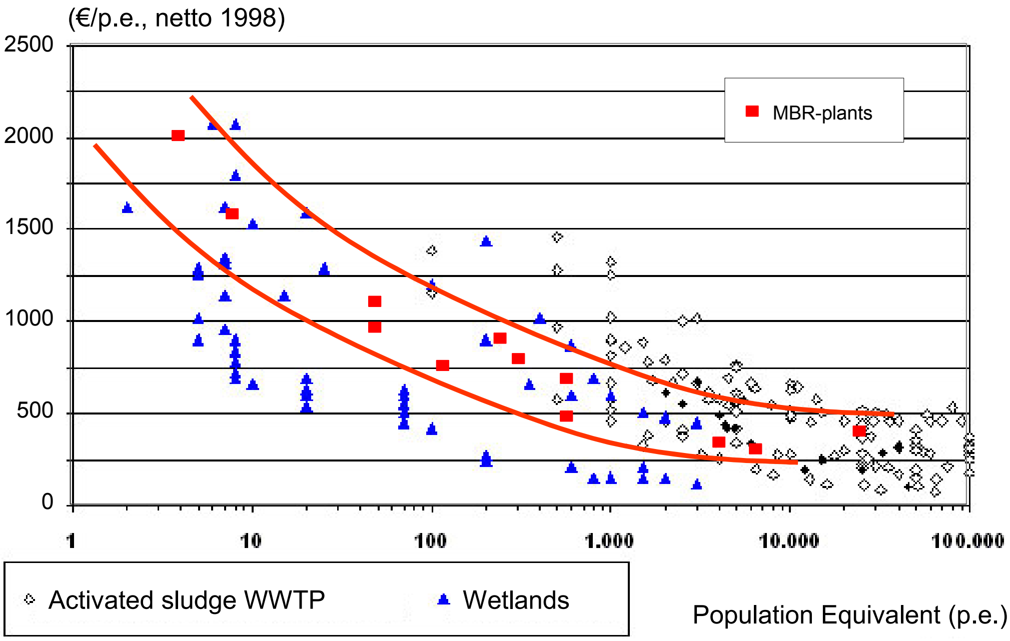
Membrane bioreactor: a novel technology ideal for small and medium-scale catchment sizes
The technology of membrane activated sludge, commonly referred to as membrane bioreactor (MBR), was first tested in the early 70’s, and consists in the combination of an activated sludge process together with a micro- or ultra-filtration step to achieve the physical separation of the treated effluent from the mixed liquor instead as a gravitary sedimentation as employed in conventional activated sludge systems.

The main advantages of the MBR technology are:

- compactness (no needs of large-footprint clarifiers, sludge concentration 3 to 4 folds higher than conventional activated sludge process);
- unsurpassed quality of treated effluent, complying with unrestricted irrigation due to the disinfection;
- stable treatment performance in time, with greater robustness to load variation and toxic shocks.

However, the main drawback of the technology still remains the capital and operation costs due to use of the high-tech membrane filtration aggregates.

Over the last decades, since the early demonstration in Japan in the early 90's, the MBR technology went through a quick development and application pace. The first European MBR plant for municipal wastewater was build in 1998 (Porlock, UK, 3,800 p.e.). In 2004, the largest MBR plant worldwide was commissioned to serve a population of 80,000 p.e. (Kaarst, Germany). These quick developments led to constant and significant cost-reduction: in 7 years, the membrane modules became 7 folds cheaper, and the operation costs fell from 1 kWh/m3 down to 0.2 kWh/m3. The picture below shows that the capital costs of the MBR technology has become competitive with other conventional processes.



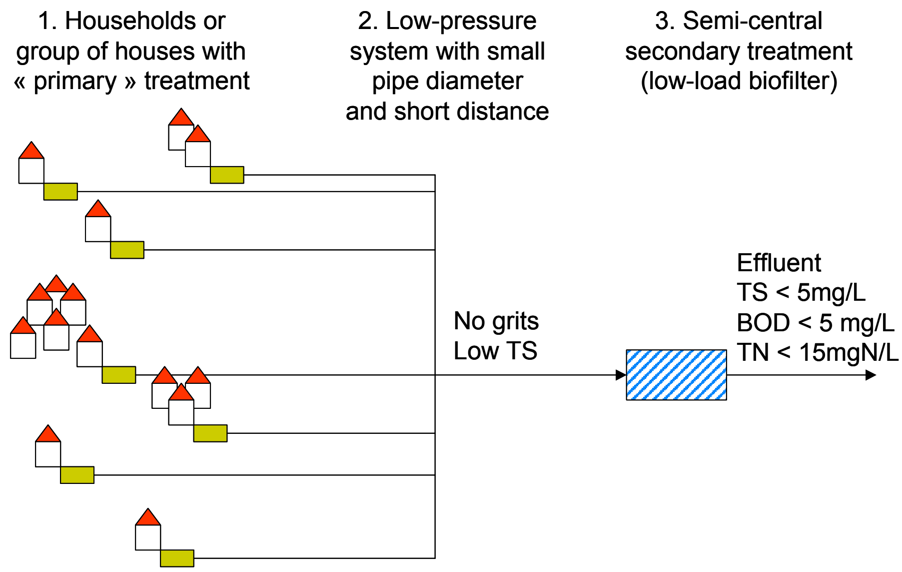
(Reicherter, 1999, und Boller, 1997)

Meanwhile, the technology was adapted and optimised to all technical conditions, and many products are now available on the market for the different application sizes. A non-exhaustive list of producers is given below for the sizes corresponding to decentral and semi-central applications:

- 4 to 50 p.e. (decentral treatment): Busse, Huber, Martin System, Malbeton, etc
- 50 to 500 p.e. (containerised-like turn-key plants for semi-central treatment): Kubota, Huber, A3, Puron, etc
- 500 to 5,000 p.e. (with standardised filtration units for semi-central treatment): Kubota, Zenon, Mitsubishi, Memcor, Huber, Puron, etc

The Berlin Centre of Competence for Water has been active since 2000 in the field of MBR technology for decentral or semi-central applications. MBR processes for advanced biological removal of nitrogen and phosphorus were developed and optimised together with Berliner Wasserbetriebe and Anjou Recherche, the research centre of Veolia Water. Such MBR processes would be much adapted for remote and unsewered areas of Berlin, requiring both disinfection and enhanced phosphorus removal. The "ENREM" demonstration project (Enhanced Nutrients Removal in Membrane Bioreactor), financed in the frame of the EU-LIFE program, will consist in building and operating such an MBR plant in a remote area of Berlin to assess the performance and the cost of the system. At commissioning, this will be the full-scale MBR plant with the strictest effluent requirements worldwide (TN < 5 mgN/L and TP < 50 µg/L).

A INTERESTING CONCEPT: HYBRID DECENTRAL AND SEMI-CENTRAL SYSTEMS
This concept, illustrated in the following figure, consists in combining the advantages of both decentral and semi-central systems, and includes three elements:
“Primary” treatment: located at each household or group of households. An advanced septic tank which includes a pre-filter or a fine screen before a pump. The solids accumulate in the tank, enhancing the anaerobic digestion. The tank is emptied in average once a year. In case of operation trouble (toxic shock etc), a sensor detects the pressure increase at the filter level and informs immediately the operator.
Low-pressure system: the effluent of the primary treatment vessels is devoid of grits or large particles, and a low-pressure sewer system with flexible pipes of small diameter can be installed to collect the primary effluent.
Semi-central treatment of primary effluent: with low load biofilter. Excellent treated water quality can be achieved, complying with most unrestricted reuse applications.



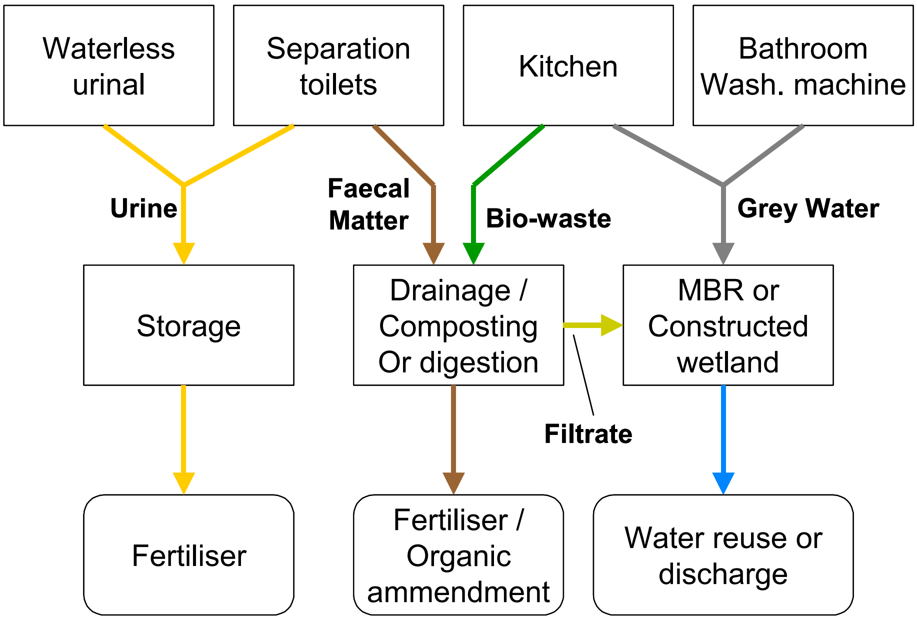
The advantages of such hybrid sanitation systems are:

- Low capital costs
- No deep trenching
- Low-pressure system with small diameter
- Flexibility of installation
- Standardised equipment
- Low operation costs
- Low-pressure system
- No chemical or aeration required in treatment step
- Low sludge production
- Central control
- Low maintenance and care (low labor)
- 1 to 2 interventions per year and per household

Such systems have been in place for 25 years in the USA, and certainly represent a cost-effective solution for low-density areas, or for areas with disseminated communities.

THE NEW CONCEPT OF ECOLOGICAL SANITATION
Over the recent years, a novel concept of sanitation has appeared, based on the observation that the different domestic and municipal water fluxes (namely grey water, yellow water, black water, rain water, etc) differ in quantity and quality. An optimised system should therefore consider each of these fluxes independently and adequately. The water fluxes should be collected separately at the source, and treated the best way according to the desired objectives in terms of treatment quality. Such systems should also enable to improve the recovery of water, nutrients or energy. Indeed, the low-loaded / high-volume water fluxes such as water run-off or grey water (showers) could be advantageously treated and reused as alternative water source. The nutrient-rich yellow water (urine) could enable optimised recovery of fertilising substances, whereas the carbon-rich black water (faecal matter) and the kitchen wastes could be used to produce biogas and energy. In order to separate the urine from the faeces at the source while minimising the water use for flushing, a novel type of toilets was developed by several companies, the so-called “separation toilets”, available with gravity flows or vacuum aspiration.

The Berlin Centre of Competence for Water has undertaken, together with the Berliner Wasserbetriebe, a demonstration project to assess such a new concept of Ecological Sanitation, which was awarded an EU-LIFE grant. During the 3.5 year SCST project (Sanitation Concept for Separated Treatment), an office building and ten private apartments located on the site of a wastewater treatment plant in Berlin will be equipped with a sanitation scheme reproducing the hydraulic flow below. The operation of this novel system has been investigated, and a cost evaluation, in comparison with the centralised strategy will be carried out. Three important side studies are also on going with German Universities, related to (i) the study of processes to treat urine while eliminating the trace organic compounds and concentrating the fertilising substances, (ii) the fertilising values of urine, urine-derived fertilisers and the biosolids produced from faeces, eventually together with bio-wastes (as soil amendments), and (iii) a Life Cycle Analysis of this scheme, compared with the traditional centralised approach, in order to evaluate the environment costs and benefits of both strategies.



CONCLUSIONS

The three technologies or schemes presented in this article can be considered as technical sanitation solutions for remote and rural areas, but also as an economical alternative in cities which are not sewered yet, especially for new settlements where the sanitation concept and infrastructure can be thought together with the urbanisation and architecture plans. Such novel concepts for decentral or semi-central sanitation schemes should be considered to build up the cities of tomorrow according to sustainable development principles, and to help achieving the United Nations Millennium Goals.

ACKOWLEDGEMENT:

The two demonstration projects “SCST” and “ENREM” benefit from subventions of the European LIFE-programme (LIFE 03 ENV/D/025 and LIFE 04 ENV/DE/058). The Berlin Centre of Competence for Water and its partners are grateful for this financial support.

Workshop I: Water Quality

Workshop Proceedings, Sven Aden, Moderator

The workshop on Water Quality was one out of three parallel workshops of the international water conference in Berlin. It took place at 5th October 2004 from 9:00am to 12:25am in room 338 of the Berlin City Hall. Working languages were English and German with simultaneous translation vice versa. Ms. Reich acting as co-moderator was assisting the moderator.
Around 20 international water experts were taking part at the workshop.
The workshop was structured as follows: After a brief welcome of the participants a short introduction to the workshop was given by the moderator.

The first part of the workshops starts with an opening presentation of Ingrid Chorus from the Umweltbundesamt, Berlin, to the problem of Eutrophication of Rivers and Lakes. Afterwards Mr. Abo el Abas, Free University Berlin, Mr. Kraft, engineering company Kraft, Berlin and Mr. Meifa, Municipal Water Authority in Shanghai gave presentations to specific problems and approaches in Kairo and Shanghai as well as to the problem of sustainable rainwater management and urban planning.
Ensuing the half an hour break the previous presentations were discussed by all participants regarding the following three aspects:

- Lessons Learned
- Best Practices
- Opportunities for Cooperation

Mr. Wicklein from Pigadi GmbH; Well Services in Berlin continued by talking about the Increase Well Yield – Water Well Services in Europe and Africa. Mr. Tabet Helal from the University of Tlemcen in Algeria concentrated on the Contamination of surface water in north-western Algeria considering an embankment dam as an example. Ms. Welte from SAGEP in Paris closed the second part of the workshop with her presentation about water quality in Paris.

The ensuing discussions of all participants focused again on the above mentioned three aspects Lessons Learned, Best Practices and Opportunities for Co-operation.

Afterwards a summary of the results of the previous presentations was given by the moderator:
The presentations and discussions pointed up that water quality corresponding to respective utilisation claims can only be assured trough integrated water management. This includes the consideration of the whole hydrological and utilisation cycle – ranging from water supply from ground, surface and rainwater, to water transportation, storing and consumption. The most important cutting site in this case is the water utilisation of end-consumers in respect to questions of waste water management, which was discussed in another parallel workshop. Also the topic of the third workshop Water Losses is closely linked to water quality (Keyword leakage of the pipe system). Monitoring systems are a central element of water management. They provide the possibility to observe the water quality and to react to deviations from the nominal value. Indeed monitoring systems must be embedded in an organisational and institutional framework which guarantees the continuity and co-existence of the monitoring system in respect of integrated quality management.
The presentations clarified that the desired water quality depends on many different variables including the hydrological regime, the legal and institutional framework (responsible for the implementation), available resources, consciousness and influence of the consumer, distributable financial means and the projected water use. Those variables characterise the basic conditions which have to be considered within the international knowledge dialogue and transfer and which are relevant for the insertion of technologies.

Within the discussion of potentials of international cooperation it became apparent that a series of diverse opportunities to learn and collect experience exist. Many developing countries have a great demand of research, further and vocational training. Add to this the implementation of adequate systems concerning the management of water quality is often loss-making. In this framework, an assertive interest of cooperation was articulated. The presentation about sustainable rainwater management, intensively discussed at the plenary session, highlighted that practical experiences in developing countries can be very enriching for the work done in Germany.

The concluding discussion showed that some institutions, firms and persons are swamped with deepening international contacts and enlarging cooperation agreements which were initiated at the conference. Here collateral support in line with bi- or multilateral cooperation agreements would be very helpful.
Summaries of the results of all workshops were presented to the plenary.

Distribution of Pollutants in the Ecosystem of Sewage Farm Kairo (I)

Yosry Abo el Abas, Free University Berlin, Institute for Geological Sciences, Hydrogeology Group, Germany

ABSTRACT

The sewage farms of Cairo, Gabal el Asfar and Abo Rawash exist since 1915 and 1936 respectively. Sewage contain generally elevated concentrations of a wide range of heavy metals and are therefore of interest particularly after long years of sewage application and its potential impact on soil, plants, groundwater and human health. The soil study shows accumulation of the heavy metals Cr, Zn, Fe, Mn, Pb, Cu and Ni in upper soil in both areas. Except some anomalies above the EU-limits, the soils of both sewage farms are contaminated, but not potentially endangered. Cr and Zn values are high in soils and also in citrus juice, in the groundwater are still around the EU-and WHO-limits of drinking water. The elevated level of Zn and Cr can be referred to industrial wastes originated from the industrial complex which is very close to the sewage farm. The high concentrations of nitrate could be the most negative impact of sewage application on the groundwater. Elevation of chloride and sulphate concentrations was also recorded.

INTRODUCTION

There is a wide international concern over a lack of food in the developing countries, particularly in those suffering form deficiencies of water for irrigation and land for cultivation. Egypt as a developing country faces the problem of overpopulation as well as lack of cultivated land, because more than 96 % of its area is an arid desert. The population could reach about 120 mln by the year 2025. Therefore, increasing the cultivated area is a necessity. Using sewage for agricultural purposes has gained importance particularly in countries of arid and semi-arid regions, where the rainfall and other water resources are depleted. Sewage is rich with initial nutrients needed for the plants. In other countries like Mexico also sewage is used for irrigation. Various countries like Egypt, Jordan, Mexico, USA and Germany, have already gained experience with sewage impact on the ecosystem (Grunewald, K. 1993; Abo el Abas, 2001). After the long term of sewage irrigation, which is rich in organic matter and organic and inorganic contaminants, the objective of this work is now arising the question: Is there any negative impact of inorganic contaminants on soil and groundwater?. The reuse of treated and nontreated sewage water has been practised in sandy Regions around Cairo city on Gabal el Asfar and Abo Rawash since 1915 and 1936 respectively (Fig. 1).

These areas are located in the Eastern and the Western fringes of the Nile Delta floodplain, where sandy soils are initially poor in nutrients, and where negative impact of sewage effluent on soil, groundwater quality and plant, is largely expected. Sources of the sewage are Cairo effluent treatment states. The total amount of treated sewage is about 5 million m3/d for Cairo. Gabal el Asfar sewage farm has a total area of 1,250 ha and Abo Rawash of 400 ha. The farms receive their main secondary treated sewage water from Birka, Gabal el Asfar, Zenin and Abo Rawash treatment stations for irrigating citrus trees, maize crops, wheat, alfalfa, eucalyptus, palms and flower plants.

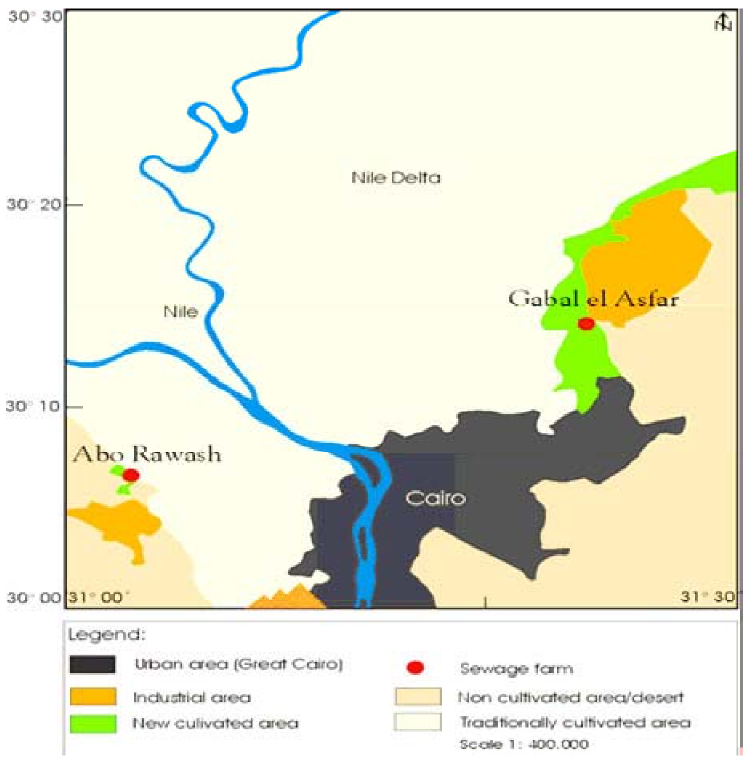


Fig. 1: Location of sewage farm Gabal el Asfar, Abo rawash, industrial areas and new cultivated areas near Cairo (Abo el Abas, 2001)

CLIMATE, GEOLOGY AND TECTONIC

The mean precipitation of Cairo is given with 125 mm/year. The average evapotranspiration is higher than 3000 mm/year. This implicates that no natural groundwater recharge takes place in this area. Both sewage farms are situated e on the rim of the Nile valley where sand and gravel of recent Quarternary build the underground. Tertiary sediments form east of Gabel el Aswar and west of Abo Rawash have the smooth slope of the Nile Valey. Vertical faults are limiting this units. Along this barrier fossil groundwater is mixed with fresh water from the Nile which is influent to the Quarternary sediments. The Nile valley forms a graben structure reaching a depth of some decade meters at the origin of the delta. East – west striking faults open gates for the groundwater flow. Such a structure takes place south of Abo Rawash. As the graben structure collected sand and gravel sediments and is highly recharged from the Nile the border faults have a barrier function and high mineralized groundwater has a small flow into the graben.

RESULTS AND DISCUSSION

The study shows that the distribution of heavy metals is analogous to organic matter in the study areas. Heavy metals decrease vertically with depth as organic matter decreases, and horizontally also inhomogeneous as well as the organic matter distributes. The XRF results show that, the upper soil is mainly contaminated with Cr, Zn, Cu and Pb (Fig. 2). Many samples with Cr and Zn exceed the permissible EU and WHO limits. Few samples contain Pb and Cu over the known limits (Fig 2).

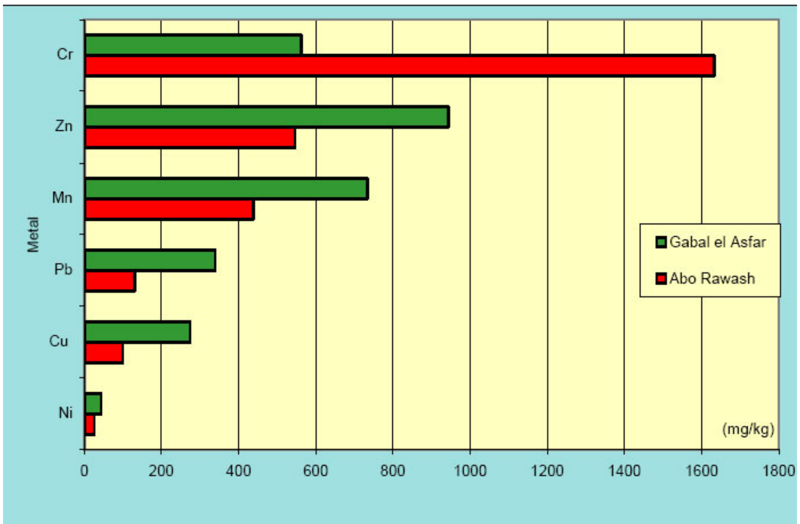


Fig. 2: Mean heavy metal content of the soil of the test fields on both sites taken in a depth of 10 cm from the fraction <200µm analyzed with XRF

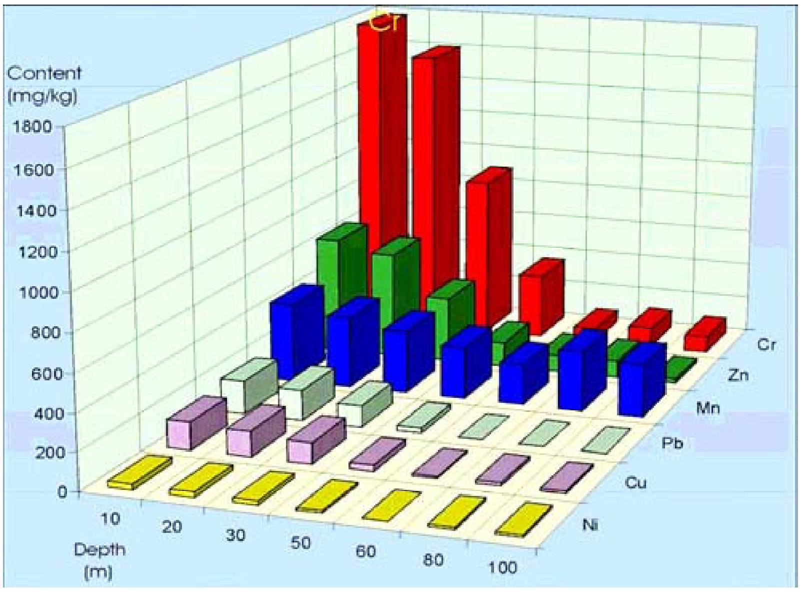


Fig. 3: Behaviour of heavy metals with depth in a soil profile of Abo Rawash sewage farm (<200µm analyzed with XRF)

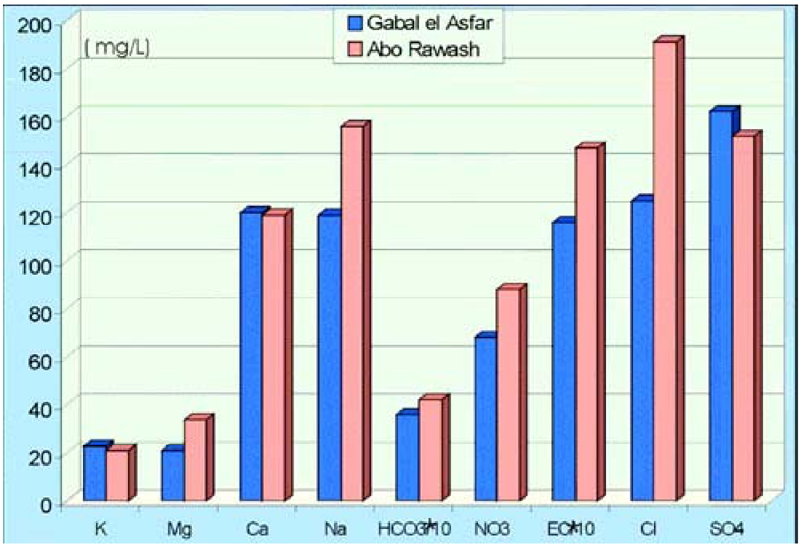


Fig. 4: The average concentration of groundwater chemical analysis in both sites

Sewage irrigation has affected not only the soil, but also the groundwater of both areas. In addition to the industrial discharge, agriculture application and hydraulic connection to the adjacent/underlain salty water of Tertiary aquifer, municipal sewage plays the main role of groundwater contamination. In Gabal el Asfar, freshening in the upper part of Quaternary aquifer took place. TDS (1000 mg/L) and EC (1160 µS/cm) decreased in comparison to the initial groundwater, High Cl- and SO42- mean values are measured (Fig. 4). NO3- mean values of 70 mg/L could be considered as a negative impact of sewage irrigation. The dominant groundwater type of sewage farm area is Ca2+-Na+ bicarbonate with relatively high Cl- and SO42-. Heavy metals Fe2+, Mn2+ and Zn2+ have been detected with relaively low values (Fig. 5). The low concentrations in municipal sewage, adsorption effects of clay lenses and clay layers and the neutral pH of the Aquifer might captured and restricted the metal's mobility.

Groundwater of Abo Rawash sewage farm area seems to be influenced by low sewage irrigation rate, hydraulic contact of the very closed salty Tertiary aquifer and also depth of groundwater, where samples have been collected. The mean values of EC and TDS (1470 µS/cm and 1185 mg/L) are relative higher than in Gabal el Asfar but also can be considered as positive indicator of sewage application. NO3- mean values of 88 mg/L exceed the known limits. Cl- and SO42- are relatively high (Fig. 4). The dominant groundwater shape in the sewage farm is Na, Ca2+ bicarbonate with high Cl- content. The only detected metals Fe2+, Mn2+ and Zn2+ concentrations are low. Industrial sewage from the closed industry area might have increased the Fe-and Mn-concentrations.

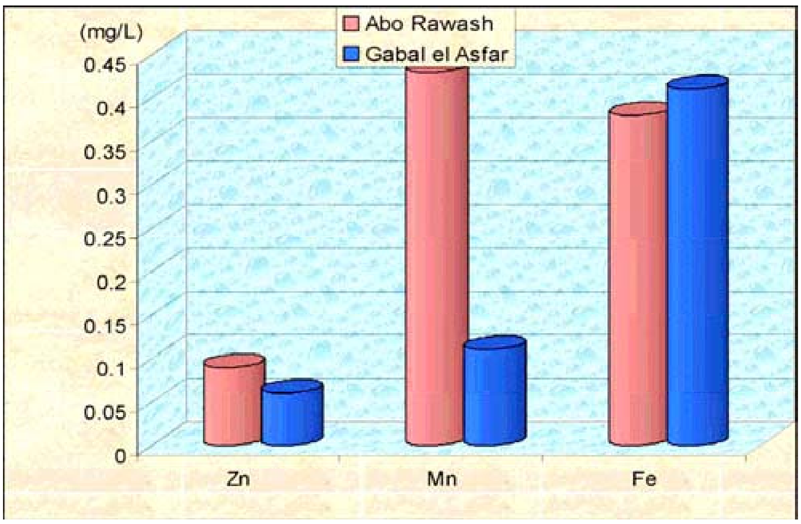


Fig. 5: The heavy metals Zn, Mn and Fe mean values in the groundwater of both sites

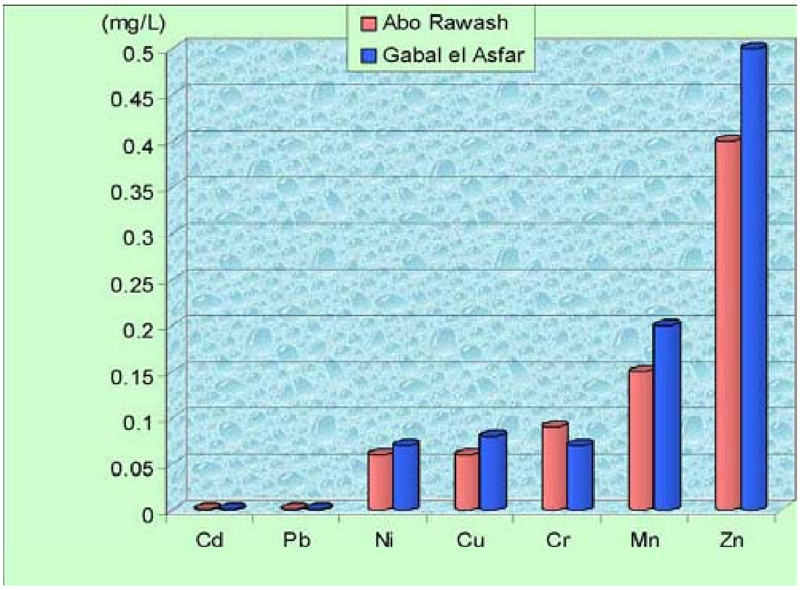


Fig. 6: The detected trace metals mean values in citrus juce in of both sewage farm (sites)

In general, groundwater constituent's concentration decreases horizontally according to the flow direction in the West. Vertically, increase with depth. The highest values lie in the West, out of the farm, in the salty Tertiary aquifer.

The groundwater in both areas is never used for drinking purposes and sometimes for domestic purposes by some inhibitors. Heavy metals have been accumulated in upper soil and have been reflected in the same order in Plants of the farms. The new founding about metal's mobility and their concentrations in citrus juice present no highly potential toxic for consumers (Fig. 6). Except few Chromium and Zick anomalies, the mean values are still around the permissible limits of WHO drinking water.

CONCLUSION

- The ecosystem of Cairo sewage farm is still not highly potentially endangered as one thought
- The Soil ist highly accumulated with Cr, Zn
- Positive impact on groundwater by lowering of TDS and EC
- Flushing and freshening of the upper quaternary aquifer
- Negative compact by nitrate and sulphate concentrations
- Trace elements and chloride concentration around permissible limits
- Concentration of trace elements in citus fruits (except Cr und Zn) are around EU and WHO-limits

RECOMONDATION

- Limimg process of the soil should take place
- Calcareous fertilisers should be used
- Avoiding the industrial discharge in sewage effluent
- Intensive discharge drains system
- Periodical controlling and monotoring
- Control the spreading of pollutants
- Construction of systematically distributed observation wells
- Behaviour and migration of pollutants with depth
- Organic and bactriological contaminants
- Cultivation of neu additional land

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Sustainable Rainwater Management and Urban Planning
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INTRODUCTION

Until the mid-90's in Germany, all storm water was treated as contaminated surface runoff and diverted away in drainage systems. Drainage took precedence over infiltration. However, with the amendments in the state water laws, the water resource management objectives became reversed, and decentralised infiltration began to take precedence over drainage. Storm water management in urban areas is basically subdivided into that for private plots and that for public property, including streets public squares, parks, or other open areas. It is primarily carried out through retention, reuse, and infiltration. Drainage of storm water as wastewater can now be seen as outdated. Storm water management intended to relieve the sewer network, infiltration to enhance groundwater recharge, and on a limited scale, the storm water collection for reuse, are finding increasingly more application in modern development projects.

THE EARLY INTEGRATED WATER CONCEPTS

(1) Project IBA Block 6, Berlin-Kreuzberg

Within the framework of "Internationale Bauausstellung" (International Housing Exhibition), Berlin 1987, a pilot project in the area of experimental housing and town planning, with a strong ecological emphasis, was to be implemented in Block 6 under the auspices of the Federal Ministry of Regional Policy, Building and Urban Construction (Bundesministerium für Raumordnung, Bauwesen und Städtebau). The objective of this demonstration project is maximum conservation of water resources through measures of reducing the drinking water consumption and environmental pollution caused by waste water. The rainwater was harvested in a rainwater pond. The domestic sewage of 73 apartments in this pilot project is pumped from a collector pit outside the building into a root zone treatment plant for biological treatment. Research on the performance of the treatment plant has shown a reduction in the pollution load to below the standards of bathing water quality (of the EC), as well as successful reuse of the effluent for irrigation and toilet flushing. This project has received an award from the President of the Federal Republic of Germany in a national competition. (Landscape Architect: H. Loidl)

STORMWATER HARVESTING AND REUSE PROJECTS IN GERMANY - THE DESIGN OF ZERO RUNOFF SETTLEMENT

(2) Project Berliner Straße 88, Berlin-Zehlendorf

In 1992 the construction of project Berliner Straße 88 was begun. The storm water from 160 housing units is collected in three cisterns making up a total storage capacity of 650 m³. The water is then reused for irrigation. The runoff is discharge into an artificial water course and a storm water pond of 1.000 m² (1.500 m³, max, depth 3 m). The pond water is recycled through the water course by solar and wind energy and continuously cleaned in a root zone treatment plant (the water percolates horizontally to the rootzone of a 1 m depth reed bed). The excess water is infiltrated through ground water recharge units. No storm water leaves the premises. (Landscape Architect: U. Grünberg)

(3) Project "Teltow-Mühlendorf"

This project area is 29 ha, comprising 1.800 housing units. (Architect: Zeidler Roberts Partnership)
Terrain Modelling
This newly developed concept assumes that all of the storm water and the necessary excavation is to stay on the project site. Using the displaced earth (250 000 m³), the terrain has been modelled so that the surface water can be diverted to a centrally located pond, resulting in a rise of about 1 m in the ground level in the centre of the project. A considerable environmental stress has been prevented by not hauling away the excavated earth, which would have require approx. 25 000 truck loads.
Storm Water Disposal for Traffic Ways

The major goal of this design is to minimise the interference of the natural water regime within the project area. In spite of the high percentage of paved and otherwise sealed areas, the precipitation remains within the boundaries of the project. The storm water runoff from sidewalks, bicycle paths, parking lanes, pedestrian walkways, green areas and playgrounds is conveyed to the subsoil through local infiltration. The runoff from the streets is intercepted in lateral gutters and conveyed to three storm water purification facilities and, after being extensively biologically treated, fed to a central storm water pond. Surplus storm water is infiltrated when complete filling of the pond forces water over the edge into infiltration trenches located in the banks. The overflow is also biologically treated prior to the infiltration in vegetated filters.

STORM WATER DISPOSAL ON RESIDENTIAL LOTS

The precipitation from all rooftops is stored in cisterns and from there made available to the residents to be used as non-potable water substitution. The surplus water is to be led to infiltration trenches. The pond water will be circulated through four natural-looking channels (flowing brooks), which run through the residential areas. The resulting cooling effect on the immediate surroundings, as well as the enhancement of the living conditions through simultaneous aeration of the lake, are the primary goals of the design concept.

(4) Project "Former Airfield Böblingen-Sindelfingen"

In this 85 ha project, the entire storm water runoff is proposed to be collected, treated and reused as a substitute for drinking water used in recreation, irrigation, toilet flushing, washing machines and still further uses where drinking water quality is not required. The excess water is discharged to a river bed. The basic aim here is that all of the storm water will be reused within the project area. (Architect: Mory Osterwalder Vielmo, Landscape Architect: Kienle)

(5) Project " Südlicher Mittelpfad" MTC DaimlerChrysler AG

In the city of Sindelfingen 40.000 people are employed by DaimlerChrysler AG to produce 4.000 cars daily. In the Mercedes-Benz-Technology-Centre (MTC) 6.500 designers and technicians are working on the development of new cars. The company plans to expand the MTC over an area of 26,9 ha including the construction of new buildings with 250.000 m² floor area and to employ up to 4.000 new staff. Based on the Town Development Plan designed by the architects Mory Osterwalder Vielmo and the landscape architect Kienle only 9,4 ha will be built-up and the remaining 17,5 ha will be a landscaped park. It is proposed to undertake the following ecological measures that include the harvesting of the entire runoff from the roads, yards and roofs, including a major public road, treating it with natural treatment methods and to create a new large lake of 1 ha in the proposed park. The surplus of treated water shall be pumped over a hill to feed a drying riverlet.

THE PRESENT DESIGN OF ECOLOGICAL SANITATION

(6) Project "International City of Auroville", India

The International City of Auroville is designed by the French Architect Roger Anger. This township is to inhabit 50.000 people within a circular area with a diameter of 2,5 km, and be surrounded by a 1,25 km wide greenbelt. The geographic centre of the township is located on a gentle hill, 52 m above sea level, 5 km from the coast of the Andaman Sea, and 200 km south of Madras. When the first settlers arrived, the hill was devastated by centuries of deforestation. Huge gullies had been caved out. The land had been cleared and the red earth was exposed to the torrential monsoon rains. The construction of Auroville began in the centre, which is to be created into a park with a spherical building, 30 m in diameter, an amphitheatre, and an old banian tree surrounded by a large lake. In the early 1970's, the place was not fit for human life, with no shade and no water. The first settlers had to control the erosion by "bunding" and reforestation, as well as provide the basic infrastructure and water supply. This has just recently been achieved. In the meantime, the population in the surrounding areas has grown, along with their ability to extract groundwater. Since the early 1990's, sea water intrusion into the coastal aquifers has been reported. Under this threat, an alternative water management scheme was developed by the author in 1992 in order to safeguard the very existence of the city. It is planned to base the entire water supply on the precipitation. The rain water is to be harvested from the roofs and stored in cisterns. The remaining surface runoff, including that from the roads, is to be captured and stored in large reservoirs within the greenbelt. After purification, it will be lifted up to the large central lake. After further purification in the lake, the overflow will be infiltrated beneath the park into the first aquifer which lies above sea level. From there, the water can be tapped by wells throughout the city. The harvested storm water is not sufficient to meet the full demand for irrigation. Therefore, the entire waste water has to be treated to meet bathing water quality standards and reused for the irrigation of agricultural lands within the greenbelt.

(7) Project "Beijing Olympic Green 2008"

This project was an International Competition for conceptual planning and design of the Beijing Olympic Green 2008. Architects:HWP Planungsgesellschaft mbH, Kienle Planungsgesellschaft Freiraum und Städtebau mbH. The Olympic Site conserves an area of 1.233 ha. It includes the Olympic Area, the Olympic Village and the Olympic Park. The Olympic Park conserves an area of 540 ha. Part of the Olympic Park is the Olympic Lake with a surface of 150 ha and a Forrest belt of 320 ha. The ecological concept aims for a favourable microclimate and includes a rainwater and wastewater management concept. The Olympic Lake is entirely fed by a rainwater harvesting system. Water management, energy supply and traffic are following the most modern concept.

Water Source Sustainable Utilization and Water Environment Management in Shanghai

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ABSTRACT
Shanghai is located in the plain and river network region, beside the Yangtze River and Eastern Sea. The trans-frontier water resources are abundant, but water pollution in the rivers is very heavy. With the development of modernization and urbanization of Shanghai, protecting sources for water supply has become one of the crucial factors that obstruct sustainable development of Shanghai economy. Hence, Shanghai Government considers water environment management as its main concern, and makes good balance between resources utilization and environmental protection. This paper focused on current situation of water resources utilization and water environment in Shanghai, studied the main factors that influence water sources utilization and presented perspective of water supply development planning. This paper also discussed the main objectives and measures of water environment management and planning.

INTRODUCTION

Shanghai is a typical coastal city depending on water for development, situated in the front of the Yangtze Delta and the end of Tai Hu watershed. It is in the plain tidally affected region. Shanghai economy developed dramatically due to abundant water resources from the Yangtze River and Huang Pu River. According to “Shanghai Urban Master Planning”, by 2020 Shanghai will be a modernized international city, the center of international economy, finance, trade and navigation and will become an optimum city for development and living. Therefore, “Shanghai water supply special planning” put forward a goal that the quality of water providing by Shanghai water supply is planning to achieve EU present water quality standard by 2010, however, to ensure high quality water sources has been a key factor to achieve this goal. Hence, Shanghai government considers water environment management as its main concern, and makes good balance between resources utilization and environmental protection. Based on high level planning, Shanghai government will take full advantage of water resources, enhance water environment management and build city water landscape, by doing this Shanghai would resume its power of “Oriental water capital”, and ensure sustainable development of Shanghai economy by sustainable utilization of water resources.

CURRENT SITUATION OF WATER RESOURCES AND WATER ENVIRONMENT

River and its Network

Shanghai is in a typical plain tidally affected region with rivers and lakes connected each other. River system is divided into two, river network and the Yangtze River mouth. River network consists of 23.8 thousand rivers with length of 2.23×104 km, 21 lakes with total area of 91km2. The density of river network is 3.41km/km2, area ratio of rivers (lakes) is 8.4%. The Yangtze River mouth under Xuliujin is 167km long (148km in Shanghai) with area of 1,109 km2, which is divided into three parts, water flows into the sea by four courses.

Water resources amountand the situation of water supply

Water resources of Shanghai include local water resources and trans-frontier water resources. Local water resources amount is 25.6×108 m3 (include groundwater amount 1.42×108 m3), and among trans-frontier water resources amount runoff from Taihu Lake and the Yangtze River mouth are 106.6×108 m3 and 9335×108 m3 respectively. Water resources amount in Shanghai is huge, but local water resources is limited and only 1/4 of current water use which far less meets water demand. Runoff from the Yangtze River and Taihu Lake are reliable and stable sources for Shanghai, however, development and utilization of these sources are not adequate; especially the construction of water source in the Yangtze River mouth is slow. At present, utilized tidewater from the Yangtze River is only 526×108 m3, which is 5.6% of trans-frontier water from the Yangtze River. To resolve the problem of water shortage, Shanghai should further develop water resources from the Yangtze River mouth.

Actual utilizable water resources

In 2002 utilizable water resources was 99.59×108 m3. Industrial water was 72.53×108 m3 (power industrial water 61.67×108 m3), domestic water was 15.08×108 m3 and agricultural water was 11.98×108 m3. Due to inadequate local water resources, utilization of water resources mainly relies on trans-frontier water resources. 34% of utilized water resources come from the Yangtze River, 38% from Huangpu River and the rest from inland rivers and groundwater. Recently, total utilized water resources increased slowly with a trend of slight decrease. Since 1996 industrial water decreased at a rate of 10%, domestic water decreased at 5%, and decrease of agricultural water was also remarkable.

CURRENT SITUATION OF WATER ENVIRONMENT AND ITS CHARACTERISTICS

Water Quality and Water Pollution of River Network

Water quality of main rivers like Huangpu River and Suzhou River has been improved since 1996, but the general situation of water environment is still in unfavorable condition. By monitoring water quality in 7334.4km-long river course (about 1/3 of total length of river course), monitoring results show that the main pollutant is organic pollutant and the length of river course with class of less than V(State Surface Water Standard in China) is 68.6% of total length of control river course. Water pollution in rural area is heavier than that in city and district. From the assessment results of ten main rivers by “Shanghai water resources bulletin”, it shows that water bodies with class of less than III are normally 5-10% of total, which means that water quality of main rivers is better than small rivers because of their big areas, strong water movement and quick water exchange, but generally water quality still needs to be improved.

Water pollution in the Yangtze river and salty water effect

Compared with water quality of river network, water in the Yangtze River mouth is good and the quantity is high. Water quality in most area of the Yangtze River mouth is in II class, only in part of area water quality is among III or IV class. Water is polluted by organic pollutant, mainly TP and CODMn. The concentration of volatile hydroxybenzene and heavy metal are low. Water quality in the center of the Yangtze River is better than that near-shore. Currently, in the Yangtze River mouth the Chloride concentration is larger than 250mg/L and such situation normally lasts a long period and annual average time of not taking water is about 45 days, which has a great impact on water use. Nangzhi and Nanggang are main areas for taking water, where water quality is normally good except that chloride concentration exceeds the standard for a relatively long time in very drought year.

PRESENT SITUATION OF WATER SUPPLY

In 2000 water supply capacity of the city was 1069×104 m3 /d, total water supply was 24.40×108 m3 and sale volume was 20.26×108 m3 in which industrial water, domestic water were 5.31×108 m3 and 11.89×108 m3.

WATER QUALITY OF MAIN SOURCES

In Shanghai, water source is mainly from surface water, including Huang Pu River, the Yangtze River and inland rivers. Upstream of Huangpu River is a main sources in Shanghai; discharge mainly comes from Jiangsu and Zhejiang provinces. Water taking from Huangpu River is about 6×106 m3/d. Water quality in Songpudaqiao (main source for taking water) is between class III and IV, only few indexes are larger than class IV and concentration of specified organic matter is larger than I~III. At present, amount of water taking from Huangpu River is 80% of water supply in Shanghai city, so it is very important to manage and protect Huangpu River properly. The Yangtze River is the second source of Shanghai, water mainly taking from Luojin section in the Yangtze River mouth. In 1990 Chenghang Reservoir was built for avoiding salty water and waste water, storing freshwater, its storage is 8.3×106 m3. Water quality is normally between class II and III, due to self-purification outflow quality from reservoir meets class II, but in winter chloride concentration exceeds standard dramatically because of salty water intrusion. Inland rivers are the sources of rural waterworks, most of which are located in tributaries of Huangpu River. Based on the investigation of 23 rural waterworks (water mainly taking from 16 rivers), water quality of rivers is normally between class IV and V. Due to unacceptable water quality, parts of rural waterworks must be closed.

PERSPECTIVE OF SOURCES FOR WATER SUPPLY

In Shanghai water resources allocation planning, the key is water resources comprehensive utilization and the main goal is to ensure supply of good water for citizen. The planning takes “Three sources and one network” as main emphasis to establish allocation system of water resources, tries to make good balance among domestic water use, industrial water use, agricultural water use, inland navigation and environmental water use and to make real-time monitoring system of water quantity and quality, match with reasonable price. Water supply planning is the key of water resources allocation planning, its main target is “stabilize quantity and improve quality, make city and rural area into one water supply system”. With measures of scientific forecast and saving water, by 2020 water supply capacity will be 1,069×104m3/d, sources will shift to upstream of Huangpu River and the Yangtze River mouth; by optimizing water supply system, 202 existing waterworks will be combined into 48 waterworks; using preprocessing water, purifying technique, supervising water quality and updating supply network, by 2010 water quality is expected to achieve current level of developed countries (EU) and achieve 2020 standard of developed countries by 2020.

MAIN FACTORS OF INFLUENCING SUSTAINABLE UTILIZATION OF WATER RESOURCES

There are three main factors that influence sustainable utilization of water resources in Shanghai: waste water discharge and management, hydrodynamic condition of river and manual regulation capacity, watershed resources allocation and environmental impact.

WASTE WATER DISCHARGE AND MANAGEMENT

In Shanghai annual total waste water discharge is 19.21×108m3 (2002). Industrial waste water is 6.49×108m3, and domestic waste water is 12.72×108m3. The ratio of waste water treatment is 60.4% present. With strong management of industrial and domestic waste water, non-point and inside source pollution, such as initial rainfall from pumping stations, agricultural waste water and surface runoff which is difficult to collect, pollutant released from bottom silt and pollutant produced by decomposition of dead matter, have more impact on water bodies than point and outside source pollution. At present Shanghai government started to carry out management to update rainfall-waste water collection system, dredge channels, clear up hyacinth and construct environmental friendly agriculture.

HYDRODYNAMIC CONDITION OF RIVER NETWORK AND MANUAL REGULATION CAPACITY

River network must have certain hydrodynamic condition to increase ability of channel dilution and purification and to improve water environmental capacity of channel. Shanghai is in the plain tidally affected region, such special natural condition results in weak hydrodynamic condition and complex water condition. In tidally affected region, due to backwater effect water updates slowly and waste water is difficult to be drained; in plain area, slope is very small and water velocity is also small, thus hydrodynamic condition is relatively worse; interaction of rivers in the network makes water condition complex. In Shanghai natural hydrodynamic condition which can be used is tide, there are two high tides and two low tides everyday.

Projects like gates and pumping stations play a great role in preventing flood, blocking tide, allocating and discharging water, improving water environment and navigation. Based on the principle of “control for outside, block for inside, divert clean water, update water”, Shanghai makes the best of capacities of gates and pumping stations and implements manual regulation to improve discharging capacity and water environment, by which water environment capacity has been increased and water quality has been improved. There are 250 gates which are distributed outside of main control sections and annual average water quantity by regulation is 60～80×108m3/yr. Currently, discharging capacity in each control section is high, but capacity of diverting water is not enough, especially in water diversion locations actual amount of water diverted is small due to water level of inside and outside gate and navigation management.

WATERSHED RESOURCES ALLOCATION AND ENVIRONMENTAL IMPACT

The Yangtze River, Huangpu River and Wusong River, connecting Shanghai with river network of watershed and communicating inland rivers with the sea, are very important in Shanghai formation and development. Management and development of the Yangtze watershed and Taihu watershed have a great impact on Shanghai (downstream of these two watersheds), and mutual needs and contradictory exist between flood discharging and water resources allocation. For instance, presently Huangpu River is responsible for 80% of flood discharging from Taihu watershed, even finishing ten major projects in Taihu watershed, it is still responsible for 50%; in Shanghai, 80% of water supply taking from upstream of Huangpu River; discharge from Taihu watershed is big enough, but water quality is not good. According to water quality monitoring data from provincial border (Water Resources Protection Agency of Taihu watershed), all rivers on border of Zhejiang and Shanghai have been polluted, and 50%~80% of rivers on border of Jiangsu and Shanghai have been polluted. The Yangtze River mouth has plenty of water resources, because of influence of diverting water from the south to the north project, Three Gorges Project, regional water use and waste water discharging, water in some area is polluted and pollution period lasts for a long time, meanwhile salty water intrusion can not be neglected. Water resources allocation and utilization and water environment protection have been crucial factors that influence water resources utilization strategy of Shanghai. We must protect water environment in Shanghai and regions around Shanghai if we need high quality water sources.

MAIN OBJECTIVES AND MEASURES OF WATER ENVIRONMENT MANAGEMENT

Objectives and Tasks of Water Environment Management

As instruction document for Shanghai water plan, “Outline of Shanghai water resources general planning” defines coordinated development between water resources and water environment as the development strategy of water construction. Water environment management planning takes all factors of inland navigation, townscape, ecological environment into consideration and establishes water environment protection system incorporated with waste water collection and treatment, long-term water diversion and channel rectification (regular dredging and long-term control), emphasizing in “one river, one lake and twelve channels” and based on “six big areas”. The main objectives: (1) by 2005, to clean channels and get rid of smell in central city, to improve water environment, to build a set of model channel sections with good water quality, landscaping and ecological environment, to basically construct a pattern of sewage collection, transportation, processing by "three lines and three plants" in the central city with 90% of facility utilization factor, 70% of sewage and sludge processing efficiency, to distinctly enhance sewage treatment level; (2) by 2020, to complete channel rectification of urbanized area and suburb, to carry on long-term management system, to achieve situation of clean water, green banks and nice view, to recover river network ecology; to construct a pattern of certalized waste water treatment by “six lines and six plants” incorporated with separate waste water treatment, to make sewage and sludge processing efficiency up to 90%.

Main Measures for Water Environment Management
To improve Shanghai water environment, every year municipal government invests billions in water environment management, which is above 3% of GDP. Three major measures for water environment management are as follows.

Waste water treatment system, waste water collection and processing system
In 1920’s Shanghai started to construct waste water treatment plant, until now there are 32 plants, daily processing capacity is 101.1×104t/d and actual processing load is 87.50×104t/d (in 2002). In 1980’s, upon request of waste water management strategy, Shanghai implemented scheme of incorporating centralized processing with separately processing and started to construct waste water collection system. Now Shanghai has 6 waste water drainage system to discharge waste water outside city, design transportation capacity of major lines is 415×104 t/d and actual transportation amount is 325.1×104 t/d (in 2002). At present, after first-step processing waste water from waste water collection system is discharged into the Yangtze River mouth and Hangzhou Bay, diluted by big water bodies, so it may decrease waste water treatment cost. According the waste water treatment planning, by 2005 Shanghai will construct 24 waste water treatment plants, the new increasing processing capacity will gain 380×104 t/d.

CHANNEL COMPREHENSIVE RECTIFICATION
To change chaos of channels, from 1998 Shanghai started Suzhou River rectification, which fostered other rivers rectification, moreover improved water environment of city. Shanghai has invested 3.7 billion RMB in river rectification for constructing flood-control wall, dredging silt, removing and mobilizing, afforesting and getting rid of rubbish and floating material. District (rural) channels basically achieved “clear surface, clean bank and have vegetation”, not only channels have been changed significantly, but also water quality has been improved, meanwhile ability of flood protection and drainage has also been enhanced. Shanghai constructed a set of model channel sections with good water quality, nice view and ecological environment, and established channel management system. There is more than 5000 full-time cleaning staff, and channels in rural area can be dredged up by mechanical equipment regularly.

WATER DIVERSION
In Shanghai, water diversion mainly depends on diverting clean water during tidal rivers and discharging waste water during ebb tide, so water can be updated regularly and water quality in inland river network can be improved. Since 1992 municipal water authorities have conducted emergent water diversion several times to improve water quality. In the case of not completely controlling pollution source, the practice has proved that using water projects to dispatch orderly is a good method to improve water quality of inland river network. Based on successful water diversion test, Shanghai water authority carries on comprehensive water diversion in Suzhou River regularly and takes flood protection, irrigation and improving water environment into consideration. Shanghai water authority organized and implemented 14 large-scale comprehensive water diversion in the whole city (diverting water 95×108m3 and discharging water 151×108m3), which accelerated movement and exchange of water, improved water quality of the upstream of Huangpu River and effectively improved inland rivers of the city. At present, water division has implemented everyday which waters in the river network can be exchange one time every month.

CONCLUSION
Shanghai municipal and district governments pay high attention to water issues. With participation of the whole society, most optimum distribution of water resources, such as supplying water with different quality, further processing, pipe network transformation and saving water, is further deepening, at the same time water environment management measures, such as “pollution interception, water diversion, river rectification and dredging”, are to be implemented. Water quality for water supply will be improved indeed, but to achieve water supply objectives of modernized international city and social economic sustainable development, Shanghai has many work to do!

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Wells – The Soul of Water Catchment.
Methods and Opportunities for the Efficient Improvement of the Water Supply in Regions with Limited or Neglected Water Catchment Capacities
Andreas Wicklein, Managing Director of Pigadi GmbH, Berlin, Germany

One of the world's greatest challenges in the coming years will be a sufficient supply of drinking water, particularly in regions with limited or neglected drinking water catchment capacities (Eastern Europe, South America, Southeast Asia and Africa).

Based on climatic conditions which cannot be influenced, an improvement of current living conditions is directly connected with the efficient use of available resources. In regions in which drinking water can only be attained from the groundwater, the functioning of wells is of existential importance.

Wherever in the past the search for hydrogeologic sources of water has been successful, and the possibility has been developed to use these through wells, the thrust of activities has to be placed on the Service of these structures for supplying the water. In the last years, the Berlin Water Group has gained experience in projects work for the improvement of the drinking water situation in south-eastern Europe, South America and Africa.
The Berlin Waterworks currently operates about 800 vertical wells and 2 horizontal filter wells, the servicing of which is handled by a special department which has existed for more than 5 decades. These activities include analyses of the current state, rehabilitation and redevelopment. The experience we have accumulated is also being put to use in international projects.

In this projects we could find out, among other things, the influence of the artificial as well as the natural recharge of well aging. The changing conditions in the flow to the well and in the pumping rates have directly impact to the clogging behaviour of the well. The results of this are different diagnosis and adapt treatments for well rehabilitation.

The thrust of the international project work to date in the field of well servicing has concentrated on

- Exploration in the target region (Assessment of the situation),
- Diagnosis and analyse of the conditions present,
- Performing feasibility studies,
- Development of strategies,
- Performing rehabilitation actions and
- Development and realisation of teaching programmes (capacity building).

The results of the activities to date have shown that it is frequently possible to reactivate the existing drinking water wells with a minimal amount of engineering effort and therefore significantly improve the local living conditions without drilling expensive new wells. In addition, we have discovered that by means of a qualified educational process of the local population, it is possible to attain a positive change in the practical handling of the drinking water catchment equipment.

Mr. Wicklein graduated from the Technical University, Dresden, Germany in 1987 with a degree in Hydrology. For the last 18 years he has worked in different capacities for the city of Berlin's water supply system.. He has been involved with projects related to well services, consulting, well rehabilitation and well maintenance management in Africa, South America, the Middle East, Turkey, Albania, Bosnia and the USA. He has sponsored and participated in many workshops on well rehabilitation and is the editor of a newly released book, "Brunnnen ein komplexes System" (Wells, A Complex System). He is the managing director of pigadi GmbH, a daughter company of Berlinwasser Holding AG.

Contamination of Surface Water in North-West Algeria Considering an Embankment Dam as Example

A.M. Tabet Helal, University Abou Bekr Belkaïd, Tlemcen, Algeria

Algeria which is confronted with economical and agricultural development and high population growth (Population explosion) has to mobilise a maximum of surface water. As a reaction to the increasing demand of drinking and irrigation water the Algerian state has invested more than 4 million US$ in the construction of embankment dams. Thereby a maximum of rainwater can be collected/ caught.
The lack/ absence of a legal framework regulating industrial, agricultural and urban waste management had led to the extreme water contamination of certain embankment dams.
The environment protection law will be implemented regularly not before beginning of the year 2005.

A newly constructed embankment dam in north-west Algeria, providing “Oran“, the capital of western Algeria (1.200.000 inhabitants) with drinking and irrigation water is taken as an example for water contamination. This will be reached through physical, chemical and biological analyses.
The Algerian state will as well invest in clarification plants to guaranty the supply of water.

Water Quality for the City of Paris – Improvement Monitoring

B. Welte, SAGEP, Paris, France

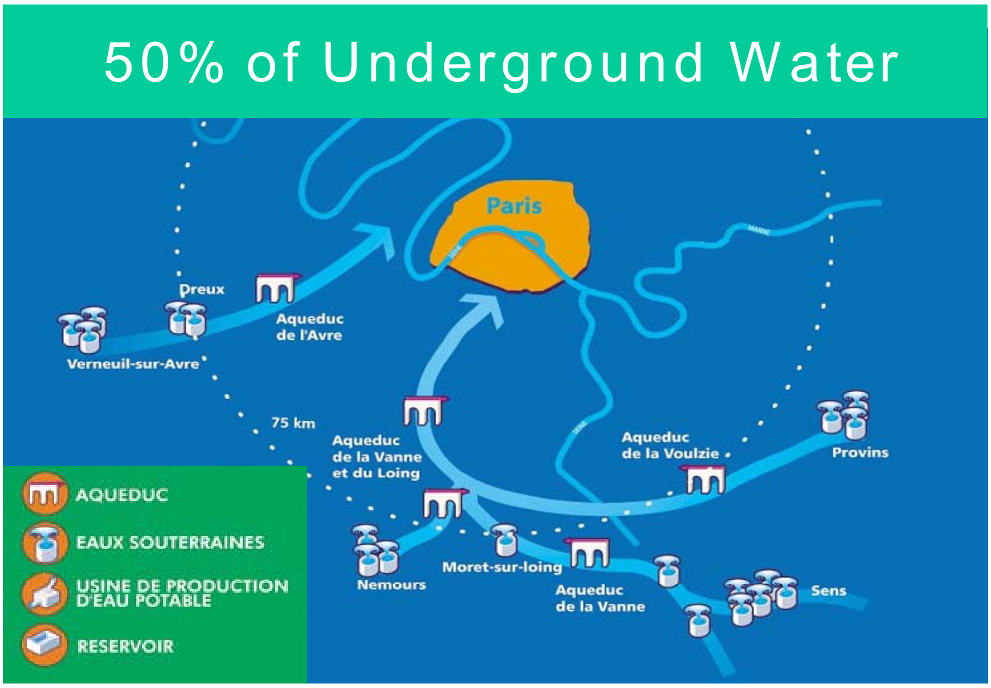
The City of Paris is situated in the centre of the Ile de France region which numbers 9 million inhabitants. Scarcely 2 million people live within Paris itself but the population doubles during the daytime, reaching a figure of 4 million. With a surface area of 10.000 hectares (100 km²), Paris is divided into two by the river Seine which flows through the centre of a basin between several hills, the highest of which, the "butte de Montmartre", peaks at 100 m above the level of the Seine. Just before entering Paris, the Seine is joined by the river Marne.

Today, and since 1987, the Société Anonyme de Gestion des Eaux de Paris (SAGEP) has been responsible on behalf of the City of Paris, its principal shareholder, for producing, transporting and guaranteeing the quality and pressure of the drinking water distributed to the City. Two private companies deal with the maintenance and renovation of the pipework in the distribution system, and with billing consumers.

As of today, the Paris water supply system comprises:

- 600 km of aqueducts (capable of transporting 510.000 m3/d)
- 72 underground water catchment areas
- 2 river water treatment plants on the Seine (each with a production capacity of 300.000 m3/d)
- 1 river water treatment plant on the Marne (with a capacity of 300.000 m3/d)
- 9 drinking water reservoirs (1.200.000 m3 storage capacity)
- 15 lift pumping stations
- 1.800 km of drinking water pipes
- 98.000 branches (one at the entry to each building)
- 3 industrial water production plants
- 1.600 km of industrial water pipes

The consumption of drinking water in Paris is on average 620.000 m3/d
The maximum production reaches 1.300.000 m3/d



In France, the European Directive 98/83 has resulted in:

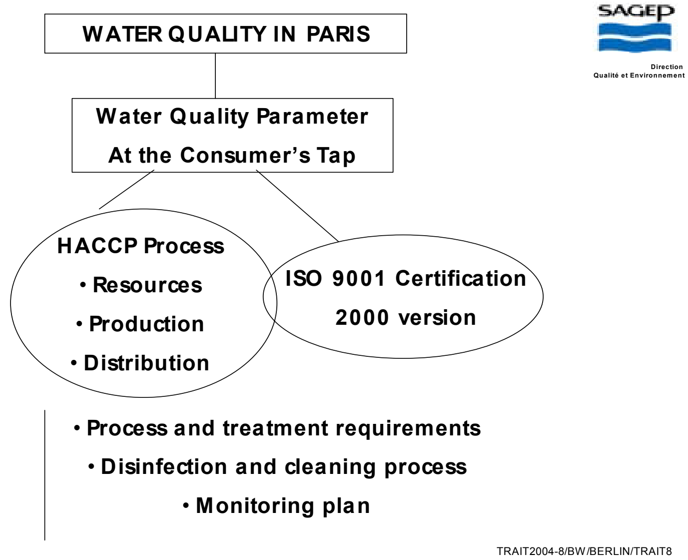
- Supervision exercised by the State: checks are carried out at the origin of the resource and during production and distribution
- Constant awareness of water quality is conditional on a thorough knowledge of all the operations liable to impact on water quality, and above all on disposing of very good traceability for these operations

Water quality in Paris is measured at the consumers'tap and also at different steps of treatment. A monitoring program has been established after a risk analysis based on the HACCP approach. This analysis has been conducted on resource, treatment plants and the distribution network.
In Paris, 2 types of resources are used : surface waters and underground waters. Certain underground waters are poorly protected and influenced by surface waters; in these waters, water quality and especially turbidity can vary very abruptly, in particular during rainy episodes: the use of on line turbidimeters

is essential for optimal management of these resources and for preventing turbid water from entering the aqueducts. On line nitrate analysers are also installed on these springs, thereby enabling one to gain a localised picture of the scale of nitrates. The establishment of protected area boundaries makes it possible to forestall accidental pollution. In underground waters, monthly physicochemical and bacteriological analyses provide one with close knowledge of the quality of these resources. Regarding certain pollutants (pesticides), analysis frequency is reinforced after periods of application. Recourse to immunoenzymatic tests permits rapid screening of the contamination.

To respect the guidelines for turbidity and pesticides, treatments of underground waters by a GAC filtration are planified and will be undertaken by the end of 2004. Other ultrafiltration and GAC adsorption treatments are being constructed.

The HACCP approach has been conducted on the treatment plants. Besides the treatment instructions, the HACCP approach has allowed to establish the monitoring program including the different steps (active steps and passive steps).
New parameters have been taken into account. For example, in order to respect the limit of 25 µg/l in BrO_3^-, studies have been undertaken. In order to reduce the timing contact between water and ozone, the choice of a very good quality household bleach containing a very low concentration in Bromate, replacement of ozone by UV



In distribution, the HACCP approach in the Paris distribution network has brought to light 26 critical monitoring points. These are spread over the reservoirs or the distribution network itself. The water quality parameters involved are essentially microbiology and turbidity while the major risk to be taken into account is that linked to the actions / works on the network.

Constant familiarity with the water quality in the distribution network is based here again on several tools :

- Modelling of the distribution network
- Continuous chlorine sensors in the network

A hundred or so continuous active chlorine sensors have been installed on the largest pipes. All the information supplied by these sensors is retransmitted in real time to the central command and control station. Any sudden and abnormal drop in the active chlorine concentration triggers an alarm as well as action on the ground. Modelling of the network, coupled with the making use of the results of the chlorine sensors has made it possible to select the most sensitive zones.
Planned manual online monitoring has been set in place. In the event of a problem in the distribution network or during works, monitoring is stepped up in the zone undergoing works.

In conclusion, the online monitoring strategy now in place allows us to satisfy the Health Code which specifies that the producer/distributor has a duty to monitor water quality on a permanent basis.
This strategy, based to begin with on risk analysis, relies on:

- Continuous measurements of pollution parameters and treatment efficiency indicators parameters
- One-off measurements the frequency of which varies as a function of the type of water, the risk and the possible variability of the parameter.

Workshop II: Water Losses

Workshop Proceedings, Barbara Unger Moderator

On October 5th, 2004, around 30 international experts in urban water management took part in a three hour workshop on one of the conference's topical focuses: the issue of Water Losses. In parallel, workshops on water quality and wastewater management took place.

The workshop aimed at facilitating exchange between the participants on the issue, after two thematic inputs on water losses had been given in the plenary on the day before: Mr Abdelkarim Asa´d had introduced a management focus in his presentation on „ Key issues in Water Demand Management leading to Minimizing Water Losses and increasing Water Savings“, and Mr Stanislaw Khramenkov had shown Moscow's approach to „ Reduction of Water Losses in Supply Mains“.

The workshop was structured in the following way: After a brief introduction to the workshop, a mention of the technical and managerial/administrative approaches to the issue, and the economic, social and ecologic dimensions to it and a proposal for proceedings, water experts gave six presentations on their specific problems and approaches, focussing and adapting their presentations to the three guiding questions:

- What is done about water losses?
- What can others learn form us?
- How could we cooperate on that issue?

After the introductory input of Mr. Andreas Hüttemann of Karl Weiss GmbH on technical innovations for pipeline maintenance such as coating and new ways of replacing tubes without digging them up, which drew the attention to technologies that are however, as participants pointed out, not within reach for the cities that needed them, presentations from cities around the world were given.

Starting with Namibia, Mr. Ferdinand Brinkmann, representative of Water and Waste Water, the City of Windhoek, presented Windhoek's efforts to minimize water losses, concluding that the optimal use of available resources is a requirement for success. Mr. Dursun Ali Çodur of Istanbul Water and Sewerage Administration (ISKI) drew the attention to Istanbul's impressive reduction of UAW (Unaccounted-for-Waters). in the past years, and the role of a study and a tender for leak reduction. Mr. Manuel Perlo of the UNAM, Mexico, reported of the Capital District of Mexico's impressive water losses (12,8m3/s) while many residents did not have access to drinking water. To remedy this situation, Mr. Perlo called on Humboldt's approach to use technology for the benefit of all. His presentation was complemented by Mr. Luis Manuel Guerra (INAINE) who called on taking into account ecological issues when discussing the topic, and on putting attention to the demand side. Francisco Guachalla of the Bolivian Branch of the Catholic Relief Service focussed on non-governmental educational and extension efforts in the Bolivian Water Sector. These main findings were visualized and discussed.

The ensuing discussion focussed on the following issues raised during the presentations:

- Motivation of staff (how to avoid brain drain of the trained ones and to motivate the technical staff)
- How to tackle water losses with frequently very little money to invest: go to demand side and pay attention to customers, eg. with prepaid meters, customer relations centres, price/consumption awareness
- Awareness raising activities and political will: customer relations are, as has been mentioned above, very important. Extension work and school activities on water savings, but also a tariff system that favours water savings, taking into account cultural aspects, can help to reduce demand and to tackle water losses.

A result of the workshop was the expressed need and interest to continue exchange on these items, paying specific attention to transferable solutions.

These findings were presented to the plenary. Specific cases and technologies were further exposed and discussed at the afternoon's market of opportunities at the Headquarters of the "Berliner Wasserbetriebe", while public private partnerships were discussed at the evening’s panel.

Measures to Reduce Water Losses

Andreas Hüttemann, Karl Weiss Technologieunternehmen GmbH & Co. KG
Berlin, Germany

BASELINE

Water is the most important food. Clean drinking water is the basis for survival of any human being.
VISION 21 Report (WSSCC, 2000, Den Haag):

Provision of acceptable drinking water for all human beings until the year 2015
In some regions of the world, water losses exceed 50 %.

Water losses are calculated as the entire water volume supplied minus the volume sold. The water loss percentage in the supply system is the most important quality feature of the pipelines' and fittings' constructional state as well as their maintenance state and operation in general.

Water losses may have the most different causes: pipe breaks, improper handling of hydrants, water flushings of the pipe system, creep loss, illegal water withdrawal, etc.

Water supply systems are subject to aging processes as well as internal and external loads which adversely affect the pipeline's tightness. Year after year, large water volumes are lost due to the leakages in the drinking water systems; in the old federal states alone 8 % - 9 %, in the new federal states an estimated 25 % - 30 % of the volume pumped and processed. In some regions of the world, the water loss even reaches 50 % or more.

IMPACT OF WATER LOSS

Costs:
Water losses cause substantial costs for the utilities which in turn allocate these costs to the water price. This alone is reason enough to take measures for efficient leakage control, detection and repair whereby damage to property and bodily injury as a result of unmonitored leakages cause even more expense for the utility as responsible party.
Environment:
The environment is also greatly affected by water losses. Although a sufficient volume of drinking water is still available in Central Europe, large areas of supply densely populated must procure their drinking water from ever distant sources in order not to dry up entire districts and deprive the vegetation of its livelihood due to drawdowns. This situation is dramatically enforced in urban areas which are located in regions with water shortage.
Hygiene:
The condition of the supply and sewer infrastructure worldwide shows the dramatic consequences entailed by deficits in the infrastructural system: 80 % of all diseases worldwide are associated with a water supply and disposal the quality and quantity of which are insufficient. In the end, only a drinking water system which is being kept in an optimal state by monitoring can comply with the principles of water supply: sufficient quantity, faultless condition and required pressure. From a sanitary point of view, the water supply system would even have to be completely tight.

INNOVATIVE TECHNOLOGIES FOR TRENCHLESS REHABILITATION OF INFRASTRUCTURAL SYSTEMS

The technology company KARL WEISS developed the hydros® and starline® procedures for trenchless rehabilitation, renewal and new installation of gas and water infrastructural systems. By applying and commercializing these efficient technologies, impairments for residents, environment and traffic associated with pipeline works are reduced to an absolutely necessary minimum. Their use is especially cost-effective and environmentally-friendly because excavations are reduced to 10 % of the conventional open-cut method.

These trenchless procedures are patented worldwide and have gained recognition beyond Berlin's and Germany's boundaries. We are successfully commercializing our products in Europe and the U.S.
starline® technologies:

Trenchless rehabilitation of pressure pipelines (more than 600 kilometers) using the fabric hose relining system. Optimized and reliable procedures are available for applications ranging from gas service connections with several 90° elbows and an internal diameter of 20 mm to water transmission pipelines with an operating pressure up to 40 bar (liner and resin comply with KTW regulations for drinking water compatibility and DVGW [German Technical and Scientific Association for Gas and Water] Worksheet W 270). The technologies have been certified by DVGW and all approvals required for gas and water applications have been granted.

The state-of-the-art starline® technologies are recognized as fail-safe rehabilitation procedures ensuring the liner's tightness even in the event of a pipe break and subsequent deflection. They are also highly economical and efficient methods since the relined pipes, with the host pipe's unweakened static condition, have the same service life as newly installed pipes.
Especially in densely populated urban areas, the starline® procedures offer the following substantial benefits:

Speed
Rehabilitations are carried out in much less time than it takes to install new pipelines. It normally takes only two days at most to disconnect, clean, rehabilitate and reconnect a pipeline section of approximately 200 meters. The starline® technologies deploy a mobile rehabilitation unit independent of the rehabilitation vehicle to enable rehabilitation in areas inaccessible to trucks.

Costs
In urban areas, the starline® technologies are particularly efficient compared to renewing and disposing of old pipelines. The rehabilitation unit itself can be disconnected from the rehabilitated pipeline after the rehabilitation operation. Several pipe sections can be rehabilitated in one day using only one set of equipment.

Environmental sustainability
By applying the starline® technologies, excavation and backfilling works are reduced by more than 90 %. This fact also reduces impairment for residents and traffic, and prevents damage to plant roots growing above and around the pipelines. It is also environmentally beneficial that the old pipelines continue to be in use, since they must not be disposed of, ond that abandoned pipelines do not remain in the overcrowded ground.

Rehabilitation
In the starline® technology, a seamless, circularly woven liner made of polyester yarns with a polyethylene coating is inverted into the pipe using compressed air and bonds to the pipe's interior wall with a solvent-free resin. To this end, the pipe must be clean (white metal).

The entire rehabilitation operation can be briefly described as follows:

- Dig launch and target pits
- Take section to be rehabilitated out of operation
- Pipe cleaning with subsequent TV inspection
- Rehabilitate including curing process and pressure test
- Reinstate service connections with TV cutter system and inspection
- Put the rehabilitated section back into operation, refill pits and restore surfaces

For the inversion, the liner is filled with a specified amount of resin. It is then run into the pressure drum by means of a defined roller gap which allows the resin to be distributed uniformly in the liner. The pressure drum containing the liner is moved to the launch pit where the beginning of the pipeline to be rehabilitated is exposed. A transportation hose connects the pressure drum to the end of the pipe. The rehabilitation is initiated by applying compressed air to the pressure drum and the liner inverts into the pipeline. After completion of the inversion process, the pressure drum is disconnected and ready for a second operation.

The starline® technology was optimized between 1993 and 1996 within the framework of a demonstration project sponsored by the Federal Ministry for the Environment, Nature Conservation and Reactor Safety. The success of every rehabilitation is guaranteed due to compliance with DIN 30658-1 requirements and the use of suitable quality control measures. Apart from the above-mentioned benefits, the rehabilitated pipelines can be tapped and continue to ensure safe operation even in the event of pipe breaks, i.e. they are leak-free.

HYDROS® TECHNOLOGIES
Trenchless replacement and new installation of pressure pipelines (more than 160 kilometers). Proven procedures specially developed for all applications, pipe materials and diameters from steel service connections DN 25 to asbestos-cement pipelines DN 400 are deployed. Their outstanding feature is that the existing pipeline is replaced by a new pipeline in one operation. The old pipeline is completely removed

from the ground and the new pipeline is installed in the same route. It can have the same or a different diameter. The hydros® technologies have been certified by DVGW and comply with all statutory requirements.
Leakages in the gas and water supply systems not only pose a considerable health hazard but also need to be repaired promptly for reasons of technical safety and economic efficiency. Especially in densely populated urban areas, the hydros® procedures offer the following substantial benefits:

- Earthworks reduced by more than 80 % and less break-up of pavements.
- Reduced impairment for traffic and residents to an absolutely necessary minimum.
- Minimize movement of large masses of soil for digging up and refilling constructions pits.
- Minimize environmental impact caused by machinery emissions, e. g. noise, vibration and pollutants.
- Minimize danger of accidents on construction sites. Very narrow trenches will hardly ever be required.
- Avoid damages to plants and roots.
- Cost-effective construction method for inner cities.

REPLACEMENT
Using the hydros® technology, the old pipeline is removed from the ground using hydraulic pulling units while the new pipeline is being installed in the same route. All methods have been developed especially with view to economic efficiency and environmental compatibility.

The hydros® technology is your method of choice if you want to increase the pipe's nominal diameter to boost transportation capacity, replace pipes in cohesive and non-cohesive soils, use lightweight equipment, to remove the old pipe completely, operate vibration-free and need to work in inner cities as well as residential areas.

Minimising Water Losses in Windhoek
Ferdinand Brinkmann, City of Windhoek Water and Waste Water, Namibia

Windhoek is located in an arid area and because of its location it is essential that water be conserved to ensure security of supply and also that losses in the distribution of water is minimised to ensure sustainability of the water supply service. The annual water consumption of Windhoek is about 21 mill. m3 with daily consumption varying between 40 000 m3 and 65 000 m3 largely depending on the weather conditions.

REDUCING WATER LOSSES IN THE DISTRIBUTION NETWORK

Water is supplied to 43 100 customers through a pipe network that is about 1353km long. Water is supplied from 14 reservoirs in 12 pressure zones. All connections are metered

Water lost or unaccounted for water has a major influence on the financial performance of the service provider and on the utilisation of the water sources. The customers pay for water lost even though they never benefited from it. With customers mainly consisting of low-income families it becomes important that they do not pay for the inefficiencies of the water distributor. With this in mind a guideline value of 12% for unaccounted-for-water was accepted to work towards.

The table below summarises the water losses or unaccounted-for-water for last five years.

Table I – Unaccounted-for Water

Year	1999/00	2000/01	2001/02	2002/03	2003/04
Water losses %	19.8	15.8	18.7	16.8	10.3

The two main sources of water losses in the distribution were identified as:

- Real losses due to pipe burst or leaking pipes
- Administrative losses related to billing errors and faulty meters.

Up to 1980 the main material used for pipes in the water reticulation network was asbestos. Since the mid eighties there has been a move to use UPVC for distribution pipelines and ductile-cast iron and steel pipes for pumping mains. Most of the asbestos pipes are well over 30 years in service and is a main source of water losses.

In order to reduce water losses and the interruption of the service due to pipe burst a pipe replacement programme was put in place to replace old pipes especially where frequent pipe burst are experienced. Pipe burst occur mainly in old asbestos pipes and these are replaced with UPVC pipes. At present about 1% of the network is replaced annually with the resources available. The target is to replace 2% of the network annually in order to keep the network in a reasonable condition.

In addition all reservoirs are fitted at their outlets with a flow meter and an actuator controlled valve. The flow is restricted to a set flow, which is linked to consumption patterns. In the event of a pipe burst the water flow increases and the valve is shut once the set flow is exceeded. This causes some frustration for customers but significant quantities of water is saved in this manner. From calculations done water losses due to pipe bursts were estimated to be about 5% of the total water produced annually.

Replacing old pipes and controlling the outflow from reservoirs had a major effect in reducing real water losses. However, unaccounted-for water due to administrative and meter errors were found to be by far the biggest contributor to the non-performance to the water service. Since 2001 the following measures were put into place to manage metering more efficiently:
A meter replacement programme was started.
The meter management programme was updated.
Regular reconciliation of the billing programme with the meter management programme.

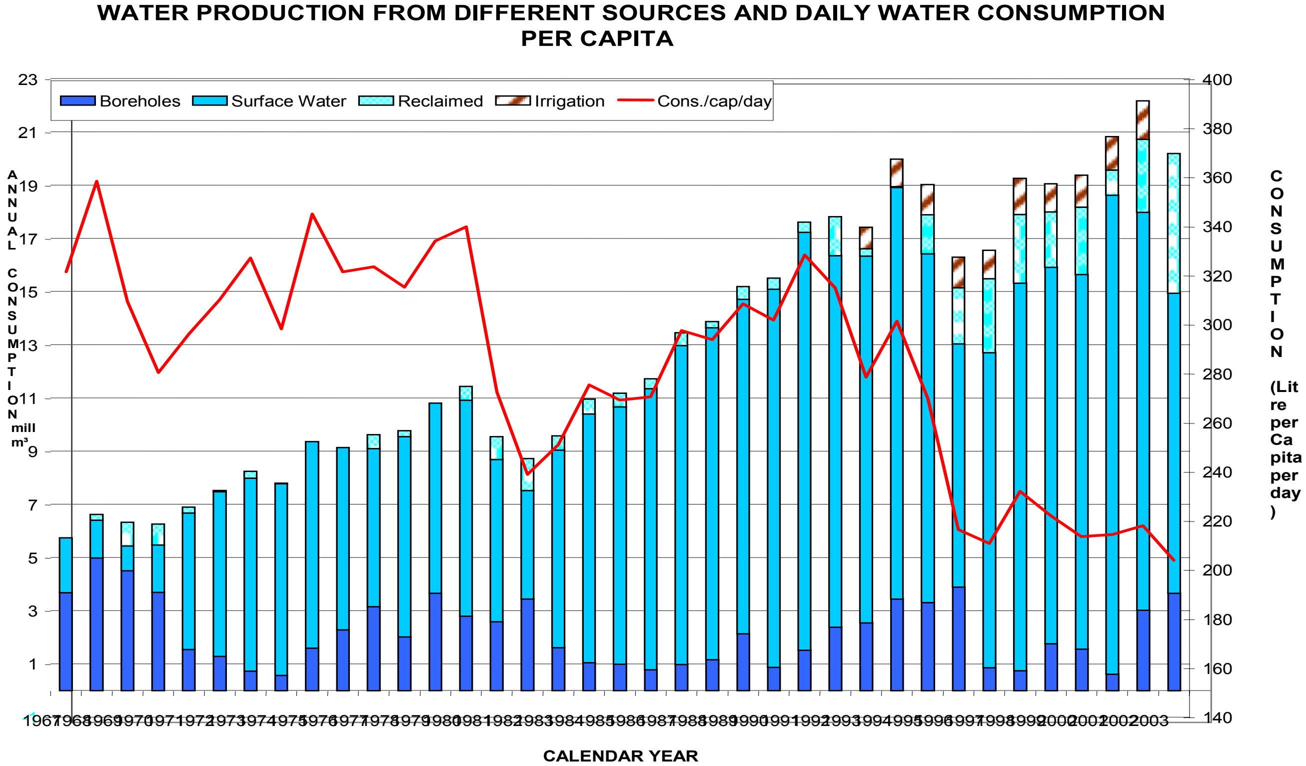
These measures resulted in:

- Detection of customers not being billed although their meters are being read.
- Detection of stuck water meters at major consumers.
- Customers being billed at the wrong tariffs.

Addressing administrative losses during the last year resulted in a major reduction of the unaccounted-for-water to 10.3%. These measures contributed to a great extend in the sound financial performance of the water services budget with price increases restricted to increases in the bulk supplies of water. For the last 3 years all cost incurred in the provision of the service was recovered from revenue.

The introduction of zone metering to monitor night flows and the consumption in informal settlements is the next step to close down on specific problem areas. Regulating the pressures areas where excessive night flows are experienced would then be introduce to reduce losses. At present data is gathered from the different pressure zones after which a plan of action for pressure management will be compiled.

ENSURING WATER SUPPLY
The main source of potable water supply to the City is the three-dam system, which at present has a safe yield of 18 million m³ per annum. In order to ensure development in the City is sustained it is necessary that water demand be controlled and that all resources are used optimally. However the inflow to these dams are so unpredictable that the whole water supply and consumption of the City is largely dependent on the well field on which the City is located and the reclamation of water from the purified effluent of the sewage treatment plant.



Managing the water demand was the largest single influence to date to ensure that water sources could meet the needs of the City. Water demand management was introduced on 1996 to cope with the drought situation then and was implemented on an add-hoc basis the following years. Since 2000 it was decided that this should be long-term strategy and that the target should be to reduce the per capita water consumption to 150l/person/day. The graph above shows the production from different sources and the per capita consumption.

The reclamation of water from wastewater is at present limited to 35% of the consumption. With a population growth of about 4.6% it is necessary that alternative sources be looked at. One option is to look at the optimal use of the well-field.

At present there are 62 boreholes of which 42 are in production. The safe yield of the well field is 1.9 million m³ per annum. During times of water scarcity the production of the boreholes is increased to 5 million m³ per annum for up to periods of two years after which the boreholes are rested to recharge naturally. Because of the high evaporation rate of about 3400mm and a low average annual rainfall of 366mm a pilot project was launched to inject water into the well-field during times of good rainfall to augment natural recharge and to abstract at high rates during times of water scarcity.

After extensive hydro-geological investigations it was estimated that the storage capacity of the well field to be about 25 mill m3. A pilot project to investigate the technical feasibilities of artificial recharge in the region showed that it was viable technically and economically.

Infrastructure was subsequently installed to start with a limited programme of artificial recharge, which can be extended in future after further investigation.

CONCLUSION
The sustainable provision of a water service can be achieved by ensuring that water losses are reduced to a minimum by applying available technologies in a rational manner. Water losses are paid for directly or indirectly by consumers and it is unfair to expect customers to pay for the inefficiencies of the service provider. Ensuring that water sources are used optimally guarantees the availability of water to sustain the services and recover cost incurred.

Reduction of Water Leakage Studies in Istanbul

Dursun Ali Codur, Istanbul Water and Sewerage Administration (ISKI)
Istanbul, Turkey

DUTIES OF ISTANBUL WATER AND SEWERAGE ADMINISTRATION

To provide water
To discharge wastewater
To protect water sources

KEY FIGURES

Population served:	11 million
Total area served:	5,220 km2
Total number of customers:	3.4 million
Total length of water networks:	12,401 km
Total length of sewers:	9,426 km
Annual yield of water resources:	1.170million m3/year
Average daily water supply:	2,000,000 m3/day
Budget (2003):	1 billion 112 million $
Investment budget (2003):	474 million $

WATER DEMAND

Years	Population (million)	Total Annual Water Demand (milion m^3/year)	Total Daily Water Demand (million m^3/day)
1990	6.6	511	1,4
1995	8.4	657	1,8
2000	10,3	694	1,9
2010	12,1	913	2,5
2020	13,6	1.059	2,9
2030	14,6	1.241	3,4
2040	15,5	1.387	3,8

DRINKING WATER INVESTMENTS

- 9 dams and regulators
- 4 drinking water treatment plants
- 5 drinking water treatment plants

RENEWING AND CAPACITY INCREASE

- 38 water reservoirs
- 57 pumping stations
- 573 km drinking water transmission line
- 6,444 km drinking water network

LEAKAGE AND ILLEGAL WATER AMOUNT (m3) (2003)

Water Supplied to City	692.238.685
Billed Water	421.432.064
Free Water	8.249.204
Meter with card	9.156.429
Illegal Water	2.477.172
Tanker	730.093
Total	**442.044.962**

REDUCTION OF WATER LEAKAGE STUDIES

- Reduction of Physical Water Leakage Studies
- Renewing and rehabilitation of main transmission line,
- Renewing and rehabilitation of water network,
- Renewing of valves,
- Isolation of water reservoirs,
- Getting under control of customer network connections,
- Renewing of 10 years age water meters,
- Repairing of nearly 100,000 breakdowns per year as quick as possible,
- Establishing and repairing of water leakage in network by seismic and electronic methods.
- Renewing of Distribution Pipes

EXISTING WATER NETWORK LENGTH

Length of Water Network Pipes Laid (km)

Type of Pipe	Length (m)
Ductile iron	12,401,000
Rehabilitation + new	2,121,664
Total	14,552,664

WATER NETWORK ACTIVITIES

Name of Activity	*2002*	*2003*	*2004 (6 Months)*
Pipe broken repair (number)	5.062	5.168	2.646
Customer network connection repair (number)	79.873	106.469	44.087

WATER LEAKAGE FROM CUSTOMER CONNECTION

Customer connections (special main tap) are damaged because of infrastructure studies. Small cracks are occurred on customer connections because of these damages. These cracks increase in time by water pressure and cause water loss. It is aimed to reduce water loss by putting a pipe clip to special main tap to strengthen the tap.

REDUCTION OF ILLEGAL WATER USAGE STUDIES

A team have been established for following illegal water usage. Illegal water users are established by technological methods and punished. All customers whose daily water consumption are decreasing are followed up by computer technology. High consumption customers are under control. (Hotels, Baths, Saunas, Private Schools, Private Hospitals)
Water meter management;
Faulty meters,
Low sensitivity meters are changed.
It is started to use meters with card.
Water Meter Workshop, İSKİ
Water Leakage Searching Methods

REDUCTION OF WATER LEAKAGE STUDIES

Two foreign companies asked pilot area to study about reduction of leakage and illegal water. They have studied in these areas without charge and they have got affirmative results.

According to these studies general tender will be done about reducing leakage and illegal water amount. It is aimed to reduce loss water percentage to 25% at first stage, to 20% at second stage, to 15% at third stage and to 11% at fourth stage.

The Rainwater in Mexico-City – A Question of Survival
Luis Manuel Guerra, INAINE, Mexico City, Mexico

Mexico-City rests on the sea ground of the former five lagoons of the “ANAHUAC”-Region. A thick impermeable layer of clay is based upon deep water reservoirs. These water reservoirs which hold the present city are being refilled by the permeable, volcanic surfaces. In this zone between the two volcanos Popocatépetl and Chichinautzin, in the south and eastern part of the basin, rain water for the reservoirs Chalco and Xochimilco is being saved. These reservoirs provide the lion’s share of the consumed water in Mexico-City.

THE DANGER

Destruction of the elevated areas for the infiltration of water through:

- Illegal deforestation and forest plaque
- Sealing of conservation grounds

DESTRUCTION OF THE PLANES BY:

Urban development and contamination

- In the hills south of the City forest plaques destruct 200 hectares every year
- Every year 70 hectares of forest are cut down illegally
- Dynamics of illegal deforestation in the southern hills

Armed groups

- Conflicts on land rights between communities
- local cutting down of young trees is tolerated by council leaders
- Illegal felling of contaminated trees
- Forest clearing for buildung houses
- Illegal felling of trees in conservation areas because of over-capacity in wood mills

Every year 300 hectares agricultural land are turned into residential areas. For every hectare which is turned into a residential area 6 million litres of water get lost and an additional demand for underground water of 23 million litres is generated. The rain water that cannot seep in the southern hills produces floods in the sealed planes below.

With a draining speed three times higher than the infiltration speed of rain water the „Chalco“ water reservoir is characterised by experts as the most excessively used water reservoir in the world. The water level in Chalco drops 1,2 m every year and also the ground above the reservoir drops about 40cm each year.

As the clay layers in the ground are drying faster and faster deep already there are deep cracks across the city. If the city should continue to grow in the southern direction in the same rate as it did in the last 40 years (1/2 million people each decade) the vitally important infiltration zone will disappear within the next 20 years and an additional demand of 91 million m^3 water will have to be provided by the reservoirs Chalco und Xochimilco.

The upper protective layer of the Chalco water reservoir will be destroyed. Both water reservoirs will be completely contaminated and the city district which is situated upon the two reservoirs will be flooded most time of the year.

Searching for Sustainability in Development- and International Cooperation Projects – A Challenge for Everybody

Dr. Francisco Guachalla, Manager for Water Resources, Planning, Monitoring and Evaluation of Catholic Relief Services – USCC, La Paz, Bolivien

By this presentation we should like to show that:
People working in sustainable projects have to be sensibilised in this issue
Effective monitoring and evaluation is an essential element in sustainable projects.

THE TERM SUSTAINABILITY

A successful project continues to exist even though the support of the project in one community is stopped. We can divide a development project into three main stages:

The most important stage E2of the implementation of the project has two components – first the component of setting up the infrastructure of the project and second the component of sensitization - and education.

Although the costs for sensibilisation amount only to 10 to 20% of the cost of the whole project it contributes 60% to the optimum level of sustainability.

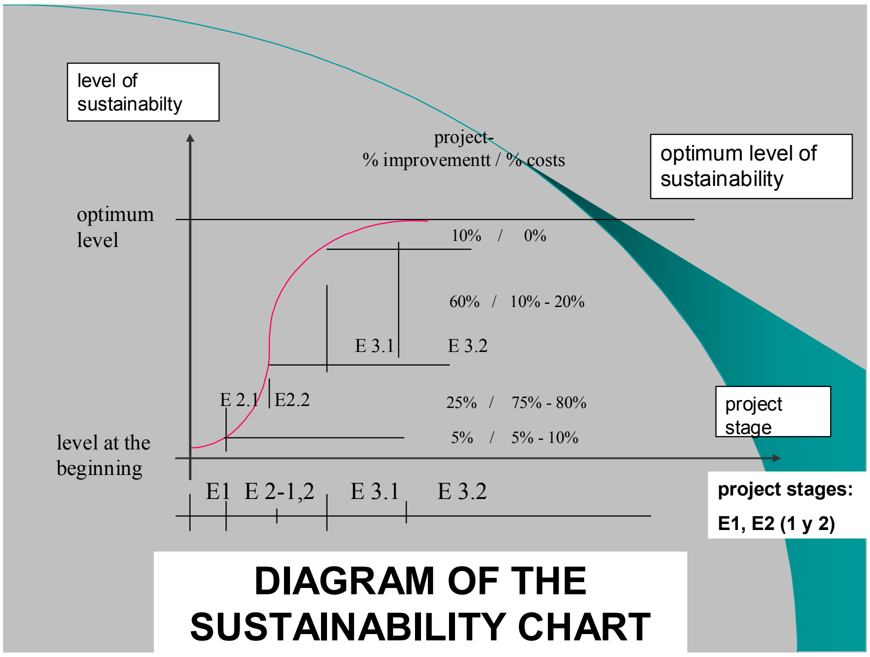


DIAGRAM OF THE SUSTAINABILITY CHART

Compared to sensitization measures the setting- up of an infrastructure produces a minimum of 75% of the costs but contributes only 25% to the optimum level of sustainability.

HYPOTHESIS OF SUSTAINABILITY

A) Fundamental services and projects work purposefully
INDICATORS

- The families contribute to their services by using the project facilities in the right way and by paying their bills in time.
- The project staff is trained and fulfils it's tasks in a reliable way.
- Basic resources and facilities are being used in an appropriate way.

B) Effective controlling- and evaluation systems
INDICATORS

- Institutional support (training, succession, monitoring and evaluation) for the staff during the project.
- Local institutions, also those responsible for education, support the community services.
- Successful implementation of monitoring and evaluation systems in public authorities.

Criteria to achieve the two Hypotheses
Participation – Education - Transfer
To achieve the three criteria we developed PLADERIS:

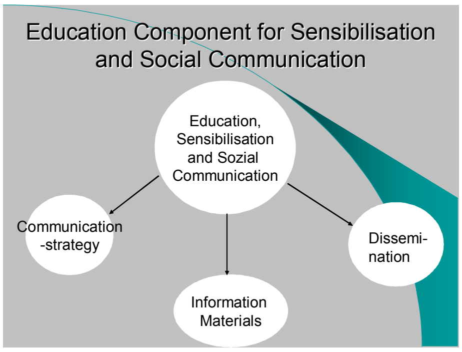
PLADERIS: Regional Integral and Sustainable Development Plan (RINEP)

COMPONENTS	A. PROJECT	B. TRANSFER / SENSIBILISATION	C. APPLIED RESEARCH
STAGE:	A.1 (Beteiligte) Diagnostic	B.1 Motivation	C.1 Systematisation
DECISION-MAKING	A.2 Integral Planning	B.2 Participation	C.2 Publication
(Preinvestment)	A.3 Adapted Outline	B.3 Organisation	C.3 Applied Technology
IMPLEMENTATION (Investment)	A.4 Construction	B.4 Training	C.4 M & E Products and Project goals
SUSTAINABILITY (Postinvestment)	A.5 Operation and Maintanance	B.5 Transfer of Experiences	C.5 Impact Control
ANALYSES OF THE FEASIBILITY	technical	Social participation	institutional
	economical	legal	ecological
SUSTAINABILITY	financial	cultural	political

PLADERIS is an organisational plan for the three stages and components of a project. As component A) Project is already well known we would like to concentrate on the components transfer and sensitization as well as on monitoring and evaluation.
The transfer of the project is based on sensitization and education of the users. Therefore we concentrate on families, schools, water committees and members of the local government.
Furthermore we try to advance the strategy in order to improve the distribution of necessary materials as well as the way they reach the users, their families, schoolchildren and authorities.

EDUCATION COMPONENT

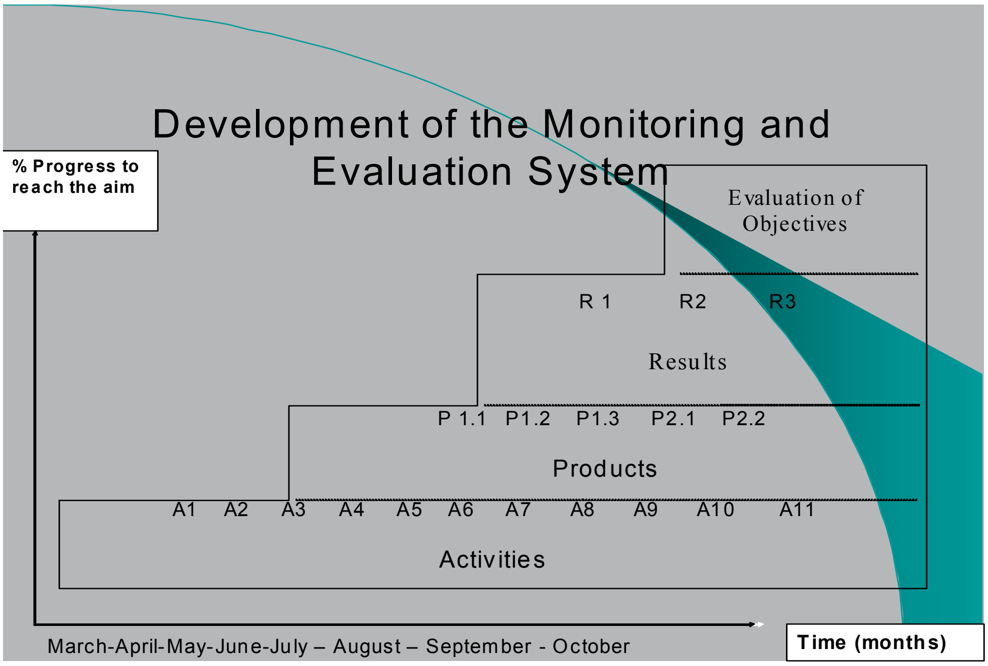
The next picture shows how the project team is organised on a monthly basis in order to support the families, schools and water committees of the communities. The duration of the module is eight months.



Organisation Module for Work in Communities

DAILY TASKS	1st week	2nd week	3rd week	4th week
Home Visits	¼ of the families	¼ of the families	¼ of the families	¼ of the families
School Work	1-3 class	4-6 class	7-9 class	10-12 class
Community Organisation	Appointees, Operator	Treasurer	Appointees Operator	President
Target Groups	male group	female group	male group	Communal Assembly

To ensure the sustainability of the project an effective monitoring and evaluation system is crucial, especially at the time when the project team leaves the communities.



Development of the M & E Systems
(continuation)

objective indicators	tasks	frequency	report
indicators for success	evaluation of progress regarding aims	after the end of the project	Participants, NGO, District
change of indicators	revision of changes	every 3 - 6 months	Manager of NGO participants
results indicators	monitoring of products	monthly	field team leader
indicators of input and process	following activities	daily, weekly	field team

The two pictures show how the monitoring and evaluation system is organised. The relation between activities, products and respective objective indicators for progress, results and changes is based on the project planning scheme. The field team and the field team leader inform the CRS Office on a monthly basis. Every three or at the larest six months a CRS project manager and responsible persons for monitoring and evaluation visit the project communities to control the changing indicators.

Workshop III: Waste Water Management

Workshop Proceedings, Ulrich Nitschke, Moderator

On October 5th, 2004, around 40 international experts in urban water and sanitation management took part in a three hour workshop on one of the conference's topical focuses: the issue of an efficient waste-water management. In parallel, workshops on water losses and water quality took place.

The workshop aimed at facilitating exchange of experiences and at strengthening networking between the participants on the above mentioned issue, taking into consideration the plenary lectures of the day before, in particular the lecture of Mr. Ludwig Pawlowski, Berliner Wasserbetriebe, on “water management in Berlin – challenges and exigencies”.

The workshop was structured in the following way: After a brief introduction by Mr Dr. Ulrich Nitschke, the moderator, explaining aim and proceeding of the workshop, Mr Dr. Bernd Heinzmann, Berliner Wasserbetriebe, gave a short thematic lecture on Berlin’s experience on wastewater treatment and its reuse.

Afterwards, nine experts gave presentations on their specific experiences and approaches, focusing and adapting their presentations on two guiding topics

Expose success factors of your specific wastewater management!
How twinning arrangements could benefit from your lessons learned?
(cf. table on issues, flipchart workshop III)

The following presentations were given:

- Mr. Drago Dolenc, JP Vodovod Kanalizacija d.o.o., Ljubljana/Slovenia - “Sewerage sytsme of Ljubljana”
- Mr. Hans Immo Peters, City of Windhoek/Namibia – “Wastewater management in Windhoek”
- Mr. Vladimir Tausanovic, Belgrade Waterworks and Sewerage/FR Yugoslavia – “Belgrade Waterworks and Sewerage”
- Mr. Klaus-Jochen Sympher, Pecher + Partner Water and Environmental Engineering Consultancy Ltd./Germany – “Sewer Rehabilitation Master Plan”
- Mr. Jean-Paul Rosiere, Ministry of Brussels Region/Belgium – “The Brussels North wastewater treatment plant”
- Mr. Leszek Drogosz, City of Warsaw/Poland – “Expansion of wastewater collection and treatment in Warsaw”
- Ms. Marlene van der Merwe-Botha, Water and Wastewater Engineering Mogale City/South Africa – “Agricultural use of sewage sludge for kikuyu grass cultivation, within the current South African guidelines”
- Mr. Felix Rupp, City of Vienna/Austria – “Smell abatement in sewage networks”
- Mr. Peter Rose, Rhodes University/South Africa – “Acid mine drainage – threat to sustainability in the Witswatersrand”

The following success factors/specific factors and benefits were highlighted:

	Success factor/specific factors	Benefit
Ljubljana	Integrated water supply and sanitation system and its management	Exchange of experience on management improvement
Windhoek	Direct water reclamation	Exchange of experience and support to cities in dry areas on how to solve their problems
Belgrade	No wastewater treatment plant, missing EC standards	Exchange of experience on financing as well as on financial management
Berlin (private company)	Transparent work flow ref. sewage rehabilitation systems	Support on how to save asset values
Brussels	Good example of private sector participation	Exchange of experience on financing
Warsaw	Appropriate strategic plan and its successful implementation	Exchange of experience on financing and appropriate technical solutions

	successful implementation	appropriate technical solutions
Mogale City/Johannesburg	Value adding to a waste product; economic and social benefit	Exchange of experience on agricultural use and sludge management
Vienna	Systemic and participatory approach	Exchange of experience on applied metering technologies
Johannesburg	Political and social awareness building	Exchange of experience on awareness building and funding options

A result of the workshop was the expressed interest to continue exchange on different aspects of wastewater management, paying specific attention to transferable and feasible solutions.

These findings were presented to the plenary. Specific cases and technologies were further exposed and discussed at the afternoon's market of opportunities at the Berliner Wasserbetriebe Headquarters as well as at the evening's panel on private sector participation.

New Methods for Discharge and Reusing the Advanced Treated Wastewater in the Region South of Berlin

Bernd Heinzmann, Berliner Wasserbetriebe, Germany, Klaus Möller and Markus Müller, UMD Möller & Darmer GmbH; Berlin, Germany

ABSTRACT

The water situation in the region south of Berlin offers an opportunity to develop projects towards a sustainable water resource management. The chosen project shows that a controlled discharge of advanced treated wastewater into a water cycle is generally a feasible method to enhance limited water resources. Since 1997 a part of the advanced treated wastewater from the WWTP Waßmannsdorf has been led in former drainage ditches through a lowland area south of Berlin. In 2000 a pilot project was carried out to close the water cycle by bringing the advanced treated wastewater to the River Dahme upstream of Berlin. These projects, which attempt to redress the disturbed water balance in the lowlands, have the following aims:

- to stop degradation of lowland soils
- to reverse the negative effect on habitats caused by the mineralisation of the organic soils
- to achieve the above without compromising agricultural interests
- to test a way to bring the (waste)water back upstream of Berlin.

Compared to solely regulating the weirs in the system of water courses, the use of advanced treated wastewater gives water management one more option: the constant supply of water makes it unnecessary now to flood the lowland in times of sufficient rainfall in order to keep enough water in the meadows for the summer. Instead the meadows get just the right amount of water and their yield is not only stabilised but sometimes increased. The results from these projects are encouraging; so far analysis show no effects on groundwater or surface water quality. They show clearly that the advanced treated wastewater can be led back upstream of Berlin without any pumping. This project could serve as a good example for both the reuse of advanced treated wastewater in a controlled water cycle and for agricultural usage, which are of worldwide importance and of special interest in areas with water shortages.

WATER SITUATION IN THE REGION SOUTH OF BERLIN

The controlled discharge of advanced treated wastewater into a water cycle is generally a feasible method for enhancing limited water resources. Regarding the water situation in the Berlin area, three points must be considered: A shortage of water occurred in the lowlands south of Berlin due to the intensive drainage and especially the closing down of the former wastewater irrigation fields (sewage farms) for the sewage treatment in this area.

Additionally the flow rate of the River Spree decreased during the last years because some of the open cast lignite mines in the river basin were closed, from which a considerable amount of groundwater had been pumped into this river (for example approximately 1 billion m3 in 1989).

Last but not least the regional climate of the region Berlin and Brandenburg (Berlin is situated in the midst of the federal state of Brandenburg) is undergoing a significant change. The climatic water balance is approaching a negative value with transpiration equalling precipitation [1].

Therefore a controlled water cycle and the reuse of advanced treated wastewater from the WWTP Waßmannsdorf could be useful. Additionally the quality of the advanced treated wastewater would be further increased by self purification and dilution processes in the natural water bodies. Furthermore, the water situation of that region would be improved to counter the lack of water that is actually a fact during the summer.

OPPORTUNITIES FOR IMPROVEMENT

This water situation in the region south of Berlin offered an opportunity to develop projects for a sustainable water resource management [2]. Since 1997 a part of the advanced treated wastewater of the WWTP Waßmannsdorf (0.35 m3/s) is not let directly into the river system of Berlin (Spree/Havel) but into smaller ditches (e.g. BÜL) in the south of Berlin that reach via the ditch Nuthegraben the small river Nuthe, which is a tributary of the River Havel [3, 4]. The Nuthegraben passes through extensive lowlands, which are under agricultural use (mostly meadows for hay making). The scarcity of water during the summers has limited the yield of the meadows. Before the advanced treated wastewater offers a constant supply of water the weirs in the system of water courses should have been closed in times of sufficient rainfall to keep the water in the meadows for the summer. Because this caused partially waterlogging, instead the weirs often have been opened during he winter, the water has been run out and the ditches have been dry during the summer. Now water management has the option to bring to the meadows just the right amount of water all over the year. This increases the yield of the meadows considerably (4 to 5 harvests per year instead 2). The disturbed water balance of these former wetlands has been partially redressed. Furthermore, so far no side-effects have been reported on groundwater or surface water quality (Table 1).

Table 1 Quality of advanced treated wastewater and of surface water in the ditches BÜL and Nuthegraben and the small river Nuthe after the discharge of advanced treated wastewater.

	Ntotal	NH4-N	Ptotal	O2	BOD	COD	Flow rate
WWTP Waßmannsdorf	14.80	1.09	0.36	4.8	3.4	53.0	0.35
BÜL	2.40	1.64	0.31	4.0	1.30	51.7	0.35
Nuthegraben	6.50	0.24	0.60	3.2	3.34	39.8	0.47
Nuthe	0.82	0.18	0.09	8.0	1.18	15.3	1.00
AGA guide line	< 8	< 1	< 0.3	> 6	< 3	< 20	----

Concentrations: 90percentil 2001, in mg/l
AGA guideline: guideline for surface water quality in Brandenburg, here class II mesotrophic water bodies
Flow rates: summer 2001, in m3/s

Therefore in 1998 the Berliner Wasserbetriebe initiated a feasibility study in order to find new methods for the discharge of advanced treated wastewater as indicated in the following two concepts (Figure 1):
Concept 1 (C1): The discharge of advanced treated wastewater into an irrigation ditch and feeding it afterwards into the canal Zülowkanal around Lake Rangsdorf.
Concept 2 (C2): Running a pilot plant for intensive filtration by means of soil filters and the discharge via Glasowbach brook through Lake Rangsdorf into the canal Zülowkanal.

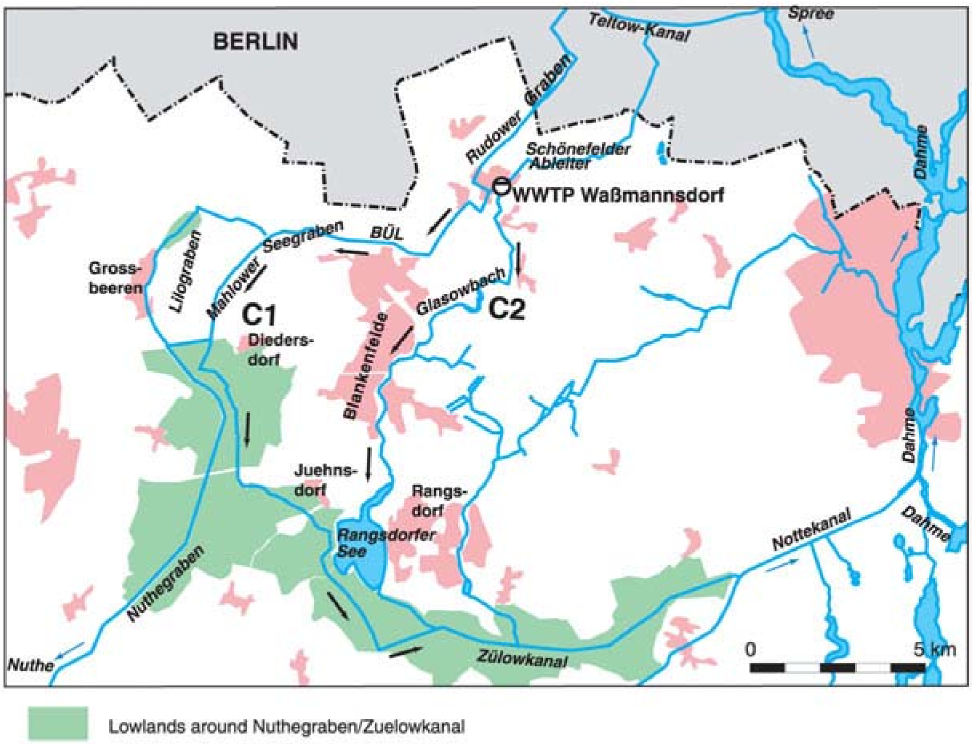


Figure 1 The two possible ways of discharging advanced treated wastewater south of Berlin

In both concepts, the water would be led through the canal Nottekanal and through the Dahme river back upstream to the River Spree, stabilizing the water balance of the urban area of Berlin.

CHOSEN PROJECT
Based on the results of the feasibility study [5] mentioned above, Concept 1 was chosen for a test performance, which was carried out in the period between February and December 2000:
A maximum amount of 0.45 m³/s of advanced treated wastewater of the WWTP Waßmannsdorf was discharged into an irrigation ditch (BÜL) and afterwards led through a wetland wood situated in a lowland around the Lilograben (Figure 1), which suffered from irregular water flows (since 1977). A part of this water (0.2 m³/s) was led (February to December 2000) south-west of Lake Rangsdorf (nature reserve) into the canal Zülowkanal [5], both situated in lowlands under agricultural use (meadows and arable land).

Within the frame of this project the following important issues were studied:

- Consequences of the water logging of the soil of a low moor (peaty flat) that is situated in the lowland of the ditch Nuthegraben
- Consequences of the water logging of the soil of a wetland wood situated in another lowland around the ditch Lilograben suffering from water shortage during dry periods, especially with respect to simultaneously ensuring no negative impact on groundwater quality [6].

Studies on the feasibility, from the hydraulic point of view, of transferring water, despite the topographic division between the systems, into the Dahme/Spree river system. Furthermore, it was necessary to investigate the impact on quality, both of the groundwater and the surface water, caused by this measure.

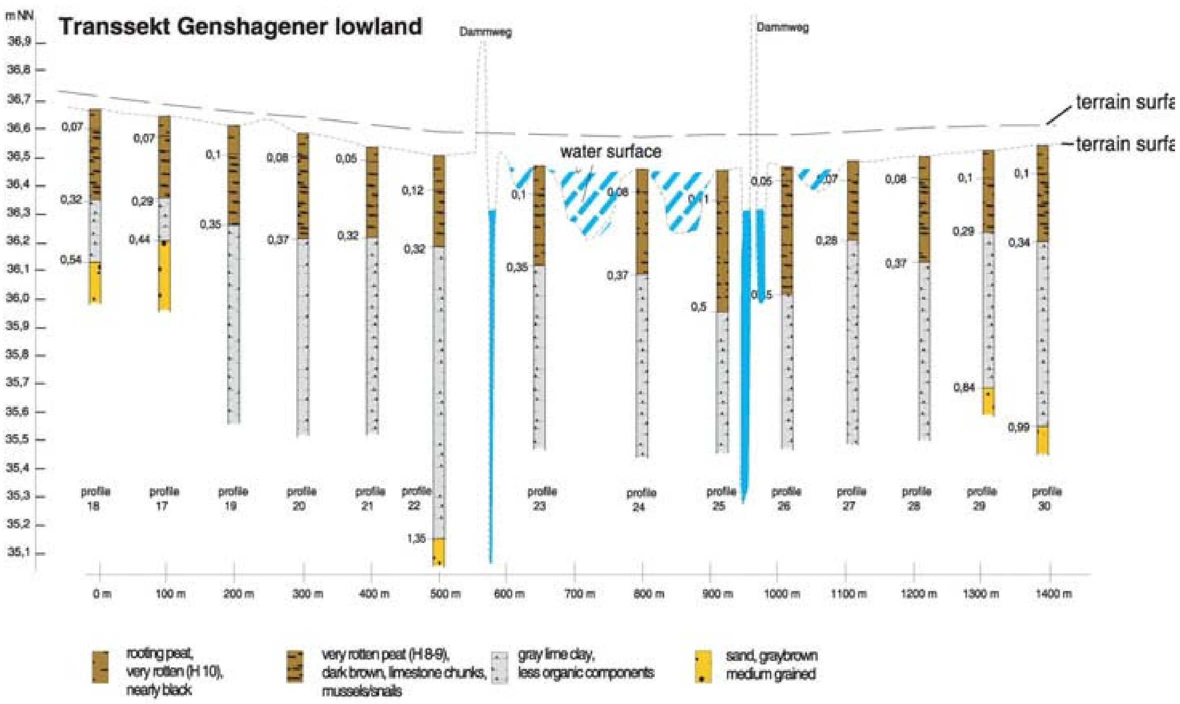
METHODS

First of all the hydrogeological situation of the affected lowlands was investigated, e.g. by core drilling and analysis of the grain size distribution and by pumping tests. Observation wells were set up in order to collect and analyse samples and to monitor the groundwater level. Thus, the situation of the soil, surface water and the groundwater was precisely known before the water logging was started. Both, the discharge of advanced treated wastewater and the water logging, was thoroughly controlled by an intensive monitoring program [7]. This has also be done for the discharge into the ditch Nuthegraben, which has become one of the regular discharge pathways of the WWTP Waßmannsdorf since 1997.

RESULTS

An intensified mineralization of the lowlands soil (low moor and the wetland wood) had taken place due to a shortage of water during the last decades. In consequence, the thickness of the low moors (peaty flat) decreased in the last 50 years by 0.15 m up to 0.50 m and was followed by a change of the flora and fauna (Figure 2). This is clearly documented by the soil profiles, which show mostly rotten peat as a result of mineralization in the organic soil layer (Figure 2). This regularly takes place, when the organic peat soil comes in contact with oxygen after the groundwater table is lowered, e.g. by drainage. This oxidation of the peat leads to a considerably loss of matter, therefore lowering the terrain surface (compare terrain surface in 1950 and 2001 in Figure 2).
After the discharge of advanced treated wastewater into the water bodies in 1997, the level of the groundwater was raised, which caused an extension of the area with a groundwater table close to the surface, also during the summer. The first result of this renewed wetting was a considerable phosphorus release from the low moor (peaty flat) into the surface water, a process which is now finished [6]. Due to the establishment of the new equilibrium conditions after some years the phosphorus was retained in the soils. The nitrate concentration of the advanced treated wastewater was reduced by denitrification processes, thus effecting a very low nitrate concentration in the groundwater. Furthermore, the aerobic degradation of organic substances was reduced causing a stabilisation of the lowland moor.

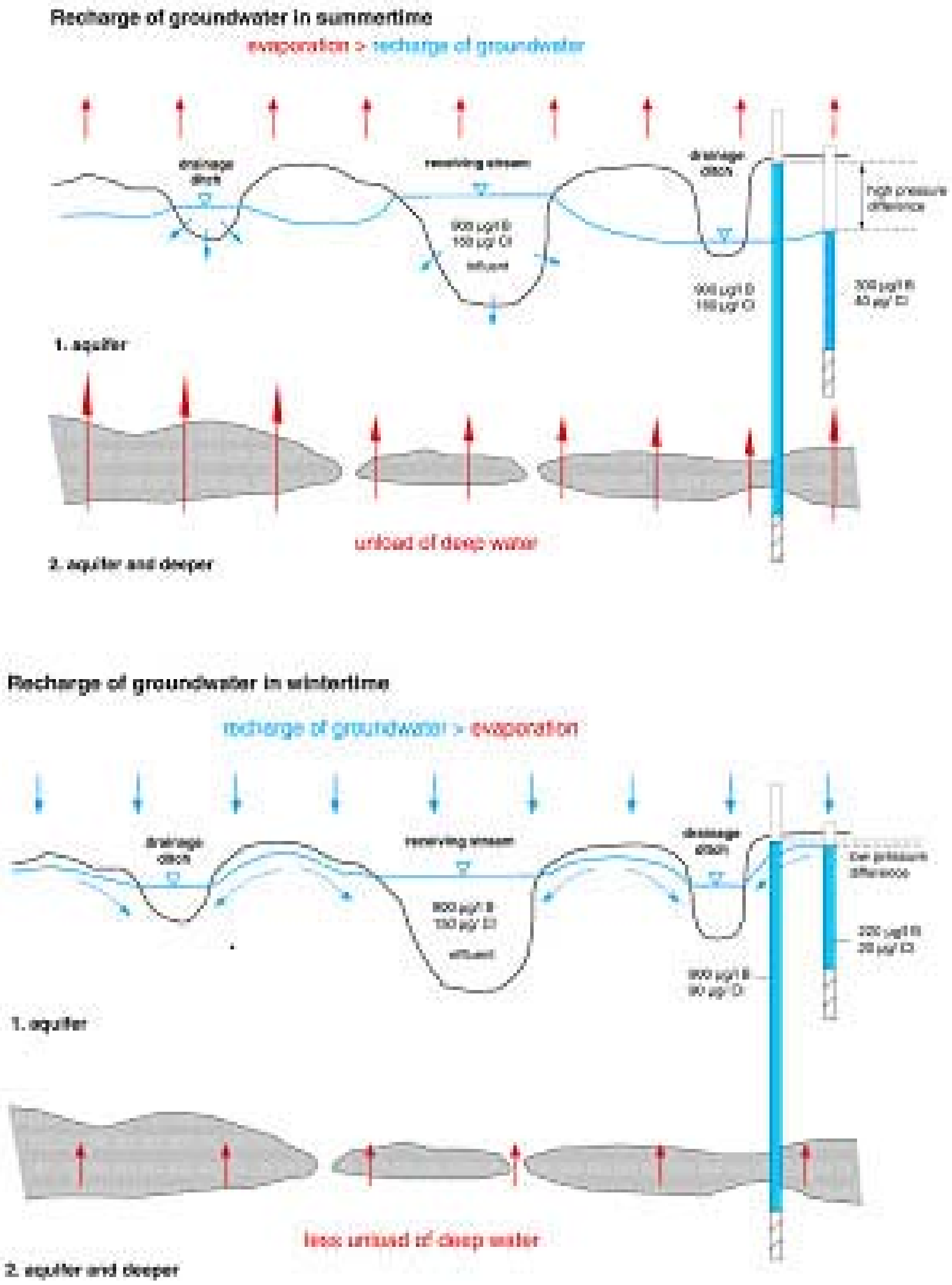
Figure 2 Typical soil profiles in the lowlands south of Berlin showing the degradation of peaty soil.



In the year 2000 the water was also led into the low moor areas, which are used as meadows, west of Rangsdorf and in the area of Diedersdorf and Jühnsdorf. The aim of this experiment was to show that it is possible to reaches the catchement area of the River Dahme without pumping. Actually a small amount of the advanced treated wastewater reaches the canal Zülowkanal confirming the possibility of a controlled water cycle. In addition agricultural production increased - e.g. the hay harvest went up from 2-3 times a year to 4-5 times a year.

Because of the high purification performance of the WWTP Waßmannsdorf the discharge of advanced treated wastewater into the lowlands of the ditches Nuthegraben and Lilograben has no effect on surface water quality (Table 1). The purification processes inside the water bodies (e.g. biodegradation, adsorption) are partially responsible for that. In addition, the effect on groundwater quality is not lasting. From the measurements carried out, emerges the picture of a “breathing landscape” with a falling groundwater table during the summer with the evaporation overwhelming the precipitation. In this situation the advanced treated wastewater infiltrates into the soil and the groundwater. During the rainfalls of the winter and the far lower rate of evaporation, the groundwater table rises again. Now the process of infiltration is mostly reversed and the advanced treated wastewater is washed out into the surface water. The presence of advanced treated wastewater in the water bodies is observed by the concentrations of chloride and boron ions, which are markers for wastewater. The described process can be seen from the values in Figure 3 in the groundwater observation well farthest from the ditch as compared to the values given for surface water.

Figure 3 Interaction of surface water, groundwater and soil.



The purified wastewater supports the conditions for wildlife and plants as well as the visual aspect of the low moor (peaty flat), which now maintains its aspect of green meadows, also during the summer. The often discussed hygienic risks of using treated wastewater in agriculture can be excluded in this case because of the long distance (12 km) the advanced treated wastewater runs from the WWTP Waßmannsdorf to the agriculturally used lowland areas and the fact that no direct contact between the wastewater and man takes place: the wastewater reaches the grass through the soil.

Generally this test phase showed that a reuse of the advanced treated sewage would be possible from the hydraulic point of view and that the quality of the groundwater as well as of the surface water would still meet the prescribed standards (Table 1).

OUTLOOK

Based on the results described, a conceptual planning (Agrarstrukturelle Entwicklungsplanung für den Landschaftswasserhaushalt) for a controlled water cycle and the reuse of advanced treated wastewater of the WWTP Waßmannsdorf, particularly for agricultural usage, has been worked out to improve the water situation of this region [7]. The test phase in 2000 has meanwhile been transformed into a planning process to secure the approval of the constant use of this method of discharge, e.g. closing the loop back to the river system of Spree/Dahme. Moreover, the advanced treated wastewater in the lowlands of the ditch Nuthegraben is actually used by the farmers to improve there production.

SUMMARY

Projects towards a sustainable and integrated water resource management (by reuse of advanced treated wastewater since 1997) were performed and showed that

- the reuse of advanced treated wastewater corresponded to paragraph 12 of the directive of the administration of the European Union for the treatment of municipal sewage from May 21, 1991.
- under appropriate geological conditions the reuse of advanced treated wastewater is suitable for the improvement of the water balance, and that this has positives effects on wildlife and plants in the affected area.

These projects could serve as a good example for a controlled water cycle and the reuse of sewage, e.g. for agricultural usage, which is of worldwide importance and of special interest in areas with water shortages. This way of discharge could be used for the improvement of the water balance in the river system Spree/ Dahme if further development is done.

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(Published in the Proceedings of the IWA World Water Congress and Exhibition. Marrakech, Morocco, September (2004)).

Sewerage System of Ljubljana
Drago Dolenc, Chief of Devlopment Service of JP Vodovod-Kanalizacija d.o.o. Ljubljana, Slovenia

Although questions of potable water quality and reduction of water leakage are very important also for Ljubljana, we would like to give to the reader some impressions about actual situation and future plans regarding the sewerage system of Ljubljana.

But first just few words and some essential data about state Slovenia and its capital city Ljubljana.
Slovenia lies on the southern part of central Europe and is surrounded with Italy, Austria, Hungary and Croatia. Its area spreads over little bit more than 20 thousand square kilometres and has 2 million inhabitants. Slovenia became independent state in 1991, since the 1st of May 2004 it's the new member of EU.

Ljubljana lies almost in the centre of gravity of Slovenia. Hills and rivers Ljubljanica and Sava gave its citizens always good protection against intruders. During the history Ljubljana became not only the political but also cultural, economical and educational centre of the country. It has 271.000 inhabitants and spreads over more than 270 square kilometres.

Sewerage system of Ljubljana origins from Roman era, when settlement Emona – on the location of contemporary Ljubljana, had settled collection of waste water through so called "kloakas". Waste water discharged directly into Ljubljanica river, was not treated but inhabitants lived in almost perfect living conditions.

Unfortunately Middle ages Ljubljana did not follow that Emona example and unsettled conditions regarding wastewater came in consideration only in time of reconstruction the city after the heavy earthquake on the 14th April 1896. Plans for rebuilding the city contained also the basic plan for Ljubljana's sewerage system. That concept – with some modifications, has been kept till today.

JP VODOVOD – KANALIZACIJA d.o.o. is one of seven public companies affiliated to Holding mesta Ljubljane d.d., which perform municipal services. The company exists since 1890. In 1994 the company's founding rights were granted to Holding mesta Ljubljane, while the company itself was restructured into a limited liability company. Basic activities: water supply, drainage and treatment of waste and precipitaton water, management and maintenance of water-supply systems, sewer systems and wastewater treatment plants.

The most intensive growth of sewerage system of Ljubljana started after year 1960 and somehow reflected the rapid growth of number of citizens after the second world war (chart 1).

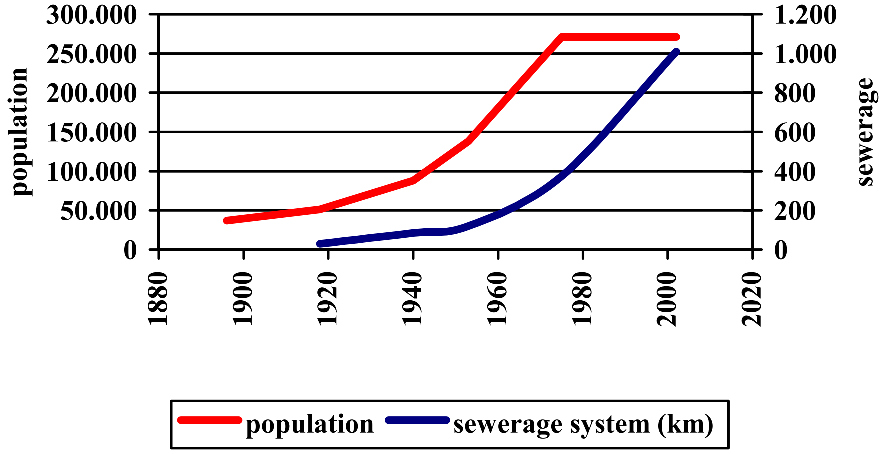


Chart 1: growth of population and sewerage system lenght in Ljubljana

The sewerage system of Ljubljana is at the moment more than 1000 kilometres long, with almost 22 thousand house connections. Actual figures can be seen below:

area covered by the sewer system:	6.136 ha
length of the sewer pipelines:	1.011,2 km
combined system:	496,9 km
separated system – waste water:	257,8 km
separated system – precipitation water:	256,4 km
average age of pipes:	35 years
number of house connections:	21.672
number of manhole shafts :	30.662
number of pumping stations:	42
number of treatment plants:	14
central treatment plant:	1

Ljubljana is still without proper treatment of wastewater. Namely, the second phase of central waste water treatment plant Ljubljana (capacity 360.000 PE) is under construction and will start with test operation in summer 2005.

Picture 1: building-ground of 2nd phase of WWTP Ljubljana

Although the sewerage system is well maintained it needs some improvements. More impermeable areas in Ljubljana mean higher level of living standard just apparently, because on the other hand that causes bigger loads for pipes and more spilled water on overflow structures into the rivers.

In 1996 a master plan for sewer system of Ljubljana was done, where some important measures were proposed. With intention to reach safer and more optimal work of sewerage system in frame of allowed influence on environment and best available practise. It is obvious that implementation of proposed measures will improve the quality of river Ljubljanica.

It is very important to know, that almost half of Ljubljana lies on the water protected areas, where city gains almost 90 percent of potable water. That is why tight sewerage system, specially on that areas, is almost vital for Ljubljana. On the other hand there are still some areas, where sewerage system is still only on planners desks. According to the forecasts this will be solved in next few years.

Expansion of Wastewater Collection and Treatment in Warsaw

Leszek Drogosz, City of Warsaw, Infrastructure Departement, Poland

Water supply and waste water collection and treatment system in Warsaw is owned and operated by Warsaw Municipal Water and Sewerage Enterprise (MPWiK S.A.). The MPWiK S.A. is a joint stock company owned in 100% by City of Warsaw.
Municipality is responsible for the approval of tariff increase and for the supervision of the MPWiK company.

The basic sources of water supplying Warsaw are the Vistula River and the Zegrzyński Reservoir. The MPWiK company uses three principal water intakes and their related water treatment stations and water supply lines:

- Central Waterworks the largest one, started operation in 1886, currently uses infiltration water and partly surface water from the Vistula River;
- Praski Waterworks started operation in 1968, drawing infiltration water from the Vistula River;
- Północny (Northern) Waterworks started operation in 1986 drawing surface water from the Zegrzyński Reservoir.

Water supply system covers 95% of the City`s population.

The Warsaw sewerage system origin goes back to the XIX th century and currently consists of three independent sub-systems:

- western sub-system, handling the western side of the city,
- Ursus district sub-system situated on the western side of the city, but connected to the Waste Water Treatment Plant in Pruszków,
- eastern sub-system (praski sub-system) handling the eastern side of the city.

Currently waste water from the western side of Warsaw, which is mostly combined, is discharged into the Vistula River without any treatment. The sewage system for the eastern side of Warsaw is mostly combined and also collects sewage from the town Legionowo line and from the towns of Marki, Ząbki and Zielonka. Waste Water Treatment Plant in Pruszków, which was recently expanded and modernized has a capacity of 52 000 m3/day. Work is already underway to separate the southern part of the sewage discharge system on the western side of Warsaw and to connect it to the “Południe” treatment plant, which is currently under construction “Południe” has a separate sewage discharge system into the Vistula river. The “Południe” treatment plant is designed for average capacity in dry weather of 112,000 m3/day. The “Południe” construction financed by Warsaw Municipality and supported by (ISPA Fund donation/for collectors), European Investment Bank (EIB) loan and National Fund for Environmental Protection (NFOŚ) will finish at the end of 2005.

The “Czajka” treatment plant was designed in the 1970’s and commenced operation in 1989-1991. It is located on the right bank of the Vistula River.
This is a biological and mechanical treatment plant with sludge digestion in closed sludge digestion chambers. The treatment plant consists of four identical technological lines, each with a hydraulic capacity of 100 000 m3/d. Designed flow capacity is 400 000 m3 of waste water per day. The real capacity of the object is lower than 240 000 m3/day, due to requirements connected with the quality of cleaned sewerage.

The sewage treatment line consists of the following facilities: separation chamber, mechanical screens, grit chambers, primary sedimentation tanks, activated sludge tanks, secondary sedimentation tanks.

The sludge management section in the plant contains the following facilities: gravitational incoming sludge thickeners, mechanical excess sludge thickeners, closed digestion chambers, digested sludge storage tank, sludge water discharge station, biogas storage tank, biogas fired power plant.

The receiver of the treated wastewater is the Vistula River - the main river of Poland which flows into the Baltic Sea. In line with the strategy for the European integration the improvement of environmental conditions in Warsaw and the Vistula River became one of the priorities of Warsaw Municipality. In accordance with the City Council resolution adopted in 1999 the existing “Czajka” WWTP is to be developed to reach the size enabling waste water purification covering the Warsaw right river bank part, as well as its left river bank area.

The planned expansion of the „Czajka" treatment plant will give a maximum capacity in rainy weather of 14,2 m3/s, average capacity in good weather of 500 000 m3/day. After modernization the Plant will treat also the sewage from the main combined collectors of central and northern part of left bank of River. It results in the necessity to transfer the sewage across the Vistula River through an inverted siphon under the river and construct several large diameter collectors connecting both systems. All above will lead to a reduction of discharge of pollutants into the river and in consequence into the Baltic Sea. The main resulting environmental benefit will be an overall increase in water quality.

The planned expansion and modernization include:

• New left bank and right bank collector system with a siphon,
• New technological draft,
• Modernization of existing technological draft:

- expansion hydraulic capacity of screen station and sand traps,
- expansion hydraulic capacity of sedimentation tanks,
- adopting existing chambers to carry out the multiphase biological process with separated zones,
- dosing of ferric coagulant and the additional source of carbon,
- construction of third line of the outflow channel to Vistula river,
- modernisation of the digesters with the accompanying infrastructure,
- new biological tanks,
- new sedimentation tanks cooperating with the new biological tanks,
- new pumping station on the output from WWTP,
- new fermentation tanks to produce volatile fatty acids,
- new digestion chambers,
- construction of the 2 new additional gravity thickeners,
- expansion of the mechanical thickening station from 300 up to 400 m3/h,
- replacement of the de-watering devices for the new ones, which allow to reach final capacity regarding to quantity and hydration grade,
- expansion of the accompanying infrastructure – pipelines, fittings, pumps, heat exchangers etc.,
- deep modernization of the biogas network,
- execution of the new boiler house.

Planned financing source of modernization is Cohesion Fund grant – 60 %, commercial bank loan – 15 %, MPWiK S.A. sinking fund – 10 %, National Fund for Environmental Protection (NFOŚiGW) loan – 10 %, Regional Fund for Environmental Protection (WFOŚ) loan – 5 %. Total costs of modernization is 1 022 mln PLN ~ 230 million €.

The schedule of modernization "Czajka" WWTP anticipates at present the selection of technical solutions (October 2004), preparation of Cohesion Fund application with feasibility study (November 2004) and putting it forward to the European Committee (December 2004). For the years 2005 – 2006, design and preparation tasks are planned. It includes sewage collector technical project, tender documentation for emerging the contractor, concept design of expansion and modernization "Czajka" WWTP, preparation of sludge management concept design. For the years 2007 – 2010, construction of sewage collector system, construction of II technological draft and modernization of I technological draft will complete.

The main problem for „Czajka" WWTP, not yet completely solved is the sludge management. Currently dewatered sediments (about 70 – 80 % water content) produced at a rate of about 120 tons per day, are currently used for land reclamation and the re-cultivation of degraded (eroded) areas.

Future sludge management requires to work out of new technology. Probably, it will be one of possible thermal utilization technologies but final decision requires deep technical and financial analysis and also social acceptance.

Wastewater Management in Windhoek
Hans Immo Peters, City of Windhoek Water and Waste Water, Namibia

GENERAL INFORMATION

Windhoek is the capital of Namibia, which is located in the south-western parts of Africa and is the driest country south of the Sahara. Namibia has a surface area of 825 000 square km and a population of approximately 1,95 million.
Perennial rivers are only found along the northern and southern borders. Within the country ephemeral rivers only spring to life during the rainy season and after heavy downpours. The country relies on these rivers (surface dams) and groundwater for its water supply.
Windhoek is situated in the Central Highlands, approximately 1600m above mean sea level. The average rainfall is 366mm, while the average evaporation is 3400mm. Of the rainfall only 2% result in surface run-off and only 1% reaches the groundwater. The rest evaporates, 83% through direct evaporation and 14% through evapotranspiration. The nearest perennial river, the Okavango, is 700 km to the north east of the city. Currently the total population of Windhoek is estimated at 250 000 (230397 after the 2001 National Population Census). At independence the number of residents was approximately 130 000. The annual population growth rate of Windhoek from 2000 to 2005 is estimated at 4,6%. The actual rate stood at 4,44% from 1995 to 2001. Migration from rural areas is the main contributor to the high growth rate.
Windhoek receives its water supply from three sources. These are the so-called State Scheme (60%) the Water Reclamation Plant (35%) and the Windhoek Aquifer (5%, maximum 20%).
From time to time water shortages occur, the last having been experienced 1992, 1996/1997, 1999/2000 and 2002/2003. The situation was critical during 1996/1997 and emergency projects were launched – water from the Berg Aukas Mine, additional boreholes in Windhoek, emergency extension of Windhoek Reclamation Plant. During annual meetings with the main supplier, the Namibia Water Corporation, the water supply situation is evaluated with a two-year horizon as basis.

WASTEWATER MANAGEMENT IN WINDHOEK

Approximately 95% of all the wastewater producers in Windhoek are connected to waterborne sewerage. The remaining 5% have alternative sanitation, such as ventilated improved pit latrines or septic tanks.

The Windhoek basin is divided into three major drainage areas. These drain towards the Otjomuise (most western parts), Gammams (southern, central, northern and eastern parts) and Ujams (northern industrial areas) wastewater treatment plants. Gravity sewers transport the waste water to these plants. Four pumpstations serve areas, which are situated outside the three areas mentioned above.

Ujams consists of four anaerobic, six transitional and four aerobic ponds. The capacity is 2,5 Mℓ/day. On average 1,5 – 1,8 Mℓ/d of industrial effluent from the northern industrial area are treated here. The main contributors are the Namibia Breweries and the Meatco Abattoir. High peaks are causing major problems, which result in unpleasant smells. Consulting Engineers have been appointed for an upgrade, which in likelihood will result in the separate treatment (in three de-centralised plants) of the abattoir, breweries and remaining industries effluents.

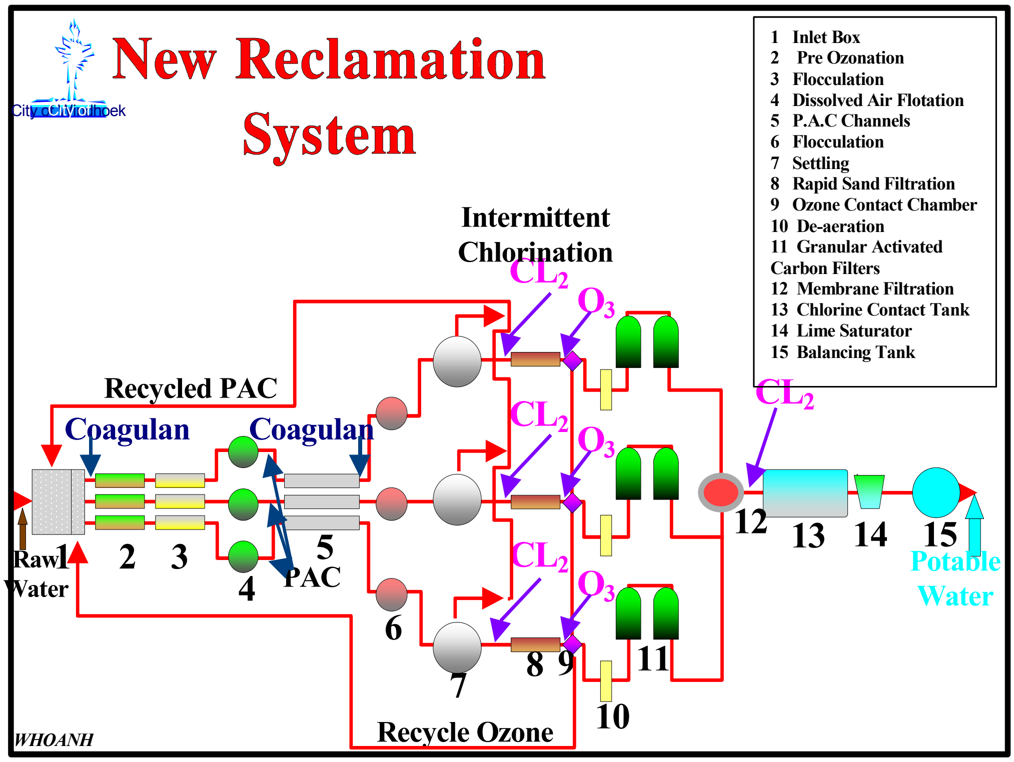
Gammams with a capacity of 32 Mℓ/day is a conventional treatment plant with two different treatment processes. These consist of trickling filters and an activated sludge plant. At Gammams mainly domestic effluent is treated, with some waste water also originating from the southern industrial area. As this plant is producing the effluent from which portable water is produced at the Reclamation Plant, the City strictly controls the type of industries allowed in the southern industrial area. These industries also have to adhere to strict industrial effluent regulations.

Otjomuise (also a conventional treatment plant) treats domestic waste water and the backwash water originating from the new reclamation plant. Phase 1 has a capacity of 7,5 Mℓ/day, which in future will be extended to 15 Mℓ/day. A tender for the construction of a pumpstation and pumping main was awarded in August 2004. The effluent will be pumped to the old reclamation plant, which will improve the quality for the irrigation of sport fields, cemeteries and parks.

The Old Reclamation Plant first started off as a conventional water treatment plant for the Goreangab Dam. It was constructed in 1959. In 1968 the City for the first time started reclaiming drinking water from effluent originating from the Gammams waste water treatment plant. The Council for Scientific and Industrial Research (CSIR) of South Africa was involved in the initial phases. Up to the construction of the New Reclamation Plant a number of upgrades were implemented to improve the treatment processes. The plant has a capacity of 14 Mℓ/day and 8 Mℓ of portable water were produced when required.

The Old Plant produced drinking water until August 2002, when the new plant was taken into operation. From then on the role of this plant was reduced to the treatment of semi-purified water for irrigation purposes. The separate irrigation system was started in 1990 to supply sport fields, cemeteries and parks, which until then had been using potable water. When fully implemented, approximately 7% of the total water consumption in Windhoek will come from this source. The semi-purified water is not fit for human consumption, only for the irrigation of plants at the institutions mentioned above.

The construction of the New Reclamation Plant started during May 1999. After many delays it was taken into operation during August 2002. This plant has a capacity of 21 Mℓ/day and can treat damwater, semi-purified water from Gammams or a blend of both.This plant is operated by a private operator. One of the co-financiers, the European Investment Bank (the other is the Kreditanstalt für Wiederaufbau) had insisted on this arrangement for the duration of the payback period of the loan. The Berliner Wasserbetriebe, Veolia and Wabag have formed a joint venture for this purpose. Tenders were called before the appointment.



The processes used at the old reclamation plant were extended to include ozonation, biological activated carbon (BAC) and membranes (ultra filtration). In future nano filtration and reverse osmosis will be added to reduce the Total Dissolved Solids (TDSs) in the final water.
The contract for the construction of the plant was awarded on the design and construct basis. Unfortunately the plant is out of operation since January 2004 due to the failure of the PSA plant, which produces oxygen for the ozone generation. Other problems include the undersizing of the membrane plant and membrane feed sump, and the consumption of chemicals in excess of the guaranteed values. Legal action is currently being taken against the contractor.

CONCLUSION
From the above it is clear that the City of Windhoek - due to the adverse climatic conditions – had to commit itself to the principle of total water re-use, within its financial means.

Sustainable Sewer Rehabilitation Strategy
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INTRODUCTION

Berliner Wasserbetriebe is in need of a significant and longterm investment in the rehabilitation of its sewer system. With ratification of the European Standard EN 752 Part 5, comprehensive rules have been set out for the rehabilitation of drain and sewer systems: hydraulic performance, environmental impact and structural integrity of complete catchment areas are given equal consideration.
Taking this into account together with the Berliner Wasserbetriebe the consultancy Dr. Pecher and Partner designed a sewer rehabilitation strategy that was tailored to the needs of the Berlin sewer system. On behalf of the German Federal Ministry for Education of Research, Pecher and Partner is currently conducting a research project that eventually will lead to a sewer rehabilitation strategy guide.

REHABILITATION STRATEGY FOR THE SEWER NETWORK

The present state of sewer rehabilitation often resembles the procedure of fire brigades deficiencies are rehabilitated without consideration of sewer network coherences. In the long run costs will increase, because inexpedient measures are taken.

The aim of the preventative sewer rehabilitation strategy is to prevent damages from occurring at all and to develop an integral concept, in which hydraulic as well as constructional, environmentally and economic relevant aspects are considered. From this follows that a strategy's main objectives are to
•Optimise investments
•prolong the mean lifetime of a sewer network
•and to conserve the asset values

The structural and hydraulic requirements, the problems and the consequences of ignoring these requirements are summarized in the following table:

Task	Problem	Consequence
Leak tightness	Exfiltration	Contamination of Groundwater
	Infiltration	Extraneous Water in WWTP
Stability	Collapse of structure	- Danger ! - Ex- or Infiltration - Breakdown of network
Function	Insufficient Capacity	Flooding

The technical requirements should be supplemented by financial requirements. In general, steady annual investments ease financial planning and justification towards citizens. The objectives of an operator therefore include watching:

- Development of wastewater charges
- Capital demand
- Network investments and
- required manpower for maintenance

Due to the long mean lifetime of a sewer network it is also important that the inter-generation contract functions. In Berlin James Hobrecht build the sewer Network in the 1880ies. Our part of the contract is at least to sustain the value of this network. To manage a sustainable network the following rules should be observed:

- Keep the network at least in the same condition as it was when you took over.
- Follow the needs of sustainability and ensure that the network reaches the designated mean life cycle.

The scope of the necessary rehabilitation measures and the resulting financial constraints therefore demand a rehabilitation strategy with concrete objectives what condition of the sewer is to be reached by which point in time.

For the ascertainment and assessment of the actual sewer condition priorities are developed as early as during preliminary planning; these priorities define the urgency of the measures to be undertaken and assist with the formulation of objectives. Given the long useful life of a sewer system, a recurring examination and adaptation of the objectives is necessary.

SEWER REHABILITATION MASTER PLAN

The aim of the sewer rehabilitation master plan is to develop a technically and economically optimal concept. The structural and operational condition as well as the hydraulic performance and environmentally relevant demands are given equal consideration. The master plan comprises of three initial development phases. The first two phases, namely the preliminary planning and the assessment of the actual condition, form the basis of the planning work, in the third phase the rehabilitation concept is developed.

As a result of the assessment of the actual structural condition, priority plans that contain a chronology for the structural rehabilitation of the sewer pipe sections are created. At this stage, each individual pipe section is still viewed on its own, without taking into consideration the neighbouring pipe sections.

REHABILITATION PLANNING

To develop an overall concept, various alternatives with partially mutual influence of hydraulic performance and structural conditions are considered. Structural solutions to rehabilitate the fabric of the sewer are grouped into repair, renovation and replacement (Stein, 2001). The decision process for selecting which structural solutions should be implemented is based on questioning the extent of damage in the examined pipe section, considering the technical and hydraulic conditions and bearing in mind the economic justification of measures of rehabilitation.

COST COMPARISON ANALYSIS

When investigating rehabilitation alternatives, the economic justification often cannot be simply answered by ‘yes’ or ‘no’. The question of costs – not only initial costs but also necessary follow-ups – is of major significance and needs thorough verification. Therefore, sewer rehabilitation and the related economic issues are best analysed by cost comparison analysis. The decision process takes into account all technically possible and appropriate rehabilitation alternatives, regardless whether it is a repair, renovation or replacement.

A compilation of specific costs and life expectancies of all measures builds the foundation for cost comparison calculations. For each pipe section alternative rehabilitation possibilities are assembled with a selection of possible measures; the respective initial costs and life cycles are fixed. At the end of each life cycle the respective rehabilitation measure is repeated, for which the corresponding reinvestments arise. Periodical reinvestments are repeated until the remaining life expectancy of the damaged pipe section expires and only a replacement maintains operation of the sewer.

The influence of interest rates and rates of increase in costs are taken into consideration by converting all future expenditures to a present worth cost. Under the condition that all rehabilitation alternatives have equivalent quality, the minimum sum of present worth costs distinguishes the most economical alternative for structural rehabilitation.

Mathematical models describing continuous decreasing sewer conditions are not suitable for cost comparison calculations to rehabilitate sewers: the condition of a pipe section might strongly differ from the calculated average condition related to a construction year or a priority group. Both parameters, construction year and prioritisation, cannot reflect the remaining life expectancy of an individual pipe section.

Depreciation should reflect the continuous decreasing value over a given time. But the remaining life expectancy of sewers cannot be derived from the construction year and the given depreciation period of bookkeeping. In Berlin there are many examples of 19th century combined sewers in magnificent condition (which are written off since a long time); on the other hand the economic struggle of the former Democratic Republic of Germany can be recognized when analysing pipes built in the 60s and 70s in the eastern part of Berlin under poor conditions and which were inadequately maintained.

With the prioritisation of pipe sections, a rehabilitation scheme is given a rank. However it has to be considered that while a single local damage can lead to a high priority, a local repair might restore the sewer with little effort.

The key factor of the residual lifetime of a pipe section is the extent of the assessed damage and the resulting costs for rehabilitation measures. A relation between residual lifetime and costs for rehabilitation measures was developed; it is used to support the engineer in his decisions when choosing the appropriate rehabilitation measure. Actual rehabilitation projects of Berliner Wasserbetriebe confirm that the selected procedure supports transparency and economic realization.

CONCLUSIONS

The sewer rehabilitation strategy in Berlin closely follows the specifications of the European Standard EN 752-5: structural, hydraulic and environmentally relevant aspects are considered equally and parallel to each other. Extensive preparatory work for the fixing of objectives and demands as well as the ascertainment and assessment of the actual condition of the sewers is carried out to develop integral solutions in rehabilitation conceptions.

The preliminary planning, the assessment of the actual condition, and the rehabilitation concept is termed the 'rehabilitation master plan'. In addition to the European Standard for sewer rehabilitation, the strategy in Berlin has a strong focus on economic issues and therefore examines all possible rehabilitation alternatives by a cost comparison analysis.

In cooperation with the German Federal Ministry for Education and Research, the Berliner Wasserbetriebe and the cities of Neuburg / Danube and Rosenheim research is carried out to broaden the understanding that the remaining life expectancy of sewers depends on the extent of failure to transport wastewater / storm water runoff from its point of origin to its prescribed destination. The objective is to develop a guide for a" Sewer Rehabilitation Strategy".

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Agricultural Use of Sewage Sludge for Kikuyu Grass Cultivation within the Current South African Guidelines

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INTRODUCTION

South Africa is considered a semi-arid country with an average rainfall of 497 mm/annum. Increased deterioration and carbon depletion of soils are a world-wide phenomenon, but specifically in South African, where the warm climate and higher microbial activity, accelerate the decomposition of the soil organic matter, with subsequent erosion and poor physical soil condition/structure (Krentajer 1991). The benefits of sewage sludge as a potential soil amendment has been realised and practiced for decades worldwide (Rowlands & Walsh, 1999; Bengtsson & Tillman, 2004) Benefits associated with sludge application to land include the supply of major plant nutrients(nitrogen and phosphorus), provision of micronutrients (Zn, Cu, Mo, Mn), improvement in soil physical properties such as better soil structure, increased solid water retention, and improved soil water transmission characteristics (Korentajer, 1991, Hughes et al., 1993, Mata-Gonzales et al., 2002). The negative effects on health and soil properties are also well identified and argued by opponents to the use of sludge in agriculture (Bengtsson & Tillman, 2004). The primary concern with sewage sludge and effluent is the fact that they contain significant and diverse quantities of pathogens, have a fairly high COD value and toxic heavy metals (in particular Cd, Cu, Mo, Ni, Pb and Cr) are normally present in sewage sludge (Murphy, 2000; Snyman et al., 2000). In particular, the long-term migration and crop-uptake of Cd limit the suitability for soil amendment on arable land (Bergkvist et al., 2003).

Despite scientific-based arguments to reduce land application of sludge, sacrificial land disposal and re-use in the agricultural sector remains a popular reality in South Africa, mainly for its economically viable- and soil conditioning benefits. But the debate which started around the 1960's when centralized waste-water purification plants were first constructed, reached maturity in 1991, when these practices had to comply with the "Guide: Sewage Sludge, Utilisation and Disposal". The sludge controversy became more involved with change in government and political views after 1994, and the Guide was revised by 1997 with considerable amendments to the heavy metal loading and usage restrictions.

The new guideline (1997) "Permissible Utilisation and Disposal of Sewage Sludge. Edition 1" was aimed to assist local authorities and operating bodies to promote safe handling, disposal and use of sewage sludge. According to these guidelines, sludge is classified in four categories:

Type of sewage sludge	Origin/Treatment	Characteristics – Quality of sewage sludge
TYPE A	Raw sludge	usually unstable and can cause odor nuisances and fly-breeding
	Cold digested sludge	contains pathogenic organisms
	Septic tank sludge	variable metal and inorganic content
	Oxidation pond sludge	
TYPE B	Anaerobic digested sludge	fully or partially stabilized
	(heated digester)	should not cause significant odor nuisance or fly-breeding
	Surplus activated sludge	contains pathogenic organisms
	Humus tank sludge	variable metal and inorganic content
TYPE C	Pasteurised sludge	certified to comply with the following quality requirements:
	Heat-treated sludge	stabilised
	Lime-stabilised sludge	0 viable Ascaris ova / 10g dry sludge
	Composted sludge	max 0 Salmonella/10g dry sludge
	Irradiated sludge	max 1000 faecal coliform / 10g
	dry sludge	(immediately after treatment)

TYPE D	Pasteurised sludge	certified to comply with the following quality requirements:
A sludge product produced for unrestricted use on land with/without addition of plant nutrients or other materials	Heat-treated sludge	stabilised
	Lime-stabilised sludge	0 viable Ascaris ova / 10g dry sludge
	Composted sludge	max 0 Salmonella / 10g dry sludge
	Irradiated sludge	max 1000 faecal coliform / 10g dry sludge
	(immediately after treatment)	

Maximum metal and inorganic content in mg/kg dry sludge (refer table)
User must be informed about the moisture and N P K content
User must be warned that not more than 8 t/ha.yr may be applied to soil and that pH of sol be higher than 6.5

The direct interpretation of the 1997 Guidelines caused that none of the wastewater treatment works could comply to a Type D sludge, which left the industry concerned and with limited options which few municipalities could immediately afford. Hence, with South African legislation taking a “conservative approach” in compiling legal limits for metal contamination, involved debates were opening up on what was perceived as excessively restrictive limits to an otherwise viable application. These guidelines caused metropolitan areas to invest large amounts of capital in thermal treatment, composting and pellitisation plants, with high operational requirements to follow. Some cities and towns were unable to afford upgrading to comply and continue practices whilst the debate continued, well aware of the fact that these were the only accepted criteria for sludge disposal by the local authority. Snyman et al. (1998) published a paper whereby 77 South African plants were evaluated for sludge quality compliance. The data indicated that not one of the wastewater treatment works complied with the Cu (50.5 mg/kg), Pb (50.5 mg/kg) or Zn (353.5 mg/kg) in sludge intended for unrestrictive use.

Mogale City, the sixth largest municipality in South Africa, situated directly outside and west of the Johannesburg metropolitan, can be described as a dense urban / industrial city, combined with scattered rural and semi-urban areas, overlying areas of environmental sensitivity and bordering a world heritage site. Mogale City was one of many municipalities who made financially-motivated decisions not to invest in expensive alternative technology. An approach to develop and optimize the existing sludge handling practice and possibilities, whilst dedicated every effort not to compromise the environment, was adopted. This approach was integrated and strengthened with the political directives to develop local SMME (Small Medium and Micro Enterprises) and increase job creation, especially targeting women and youth.

The sludge handling method of the day comprises of the disposal, irrigation and beneficial use of anaerobically digested / stabilised sludge onto instant lawn farmland. This practice were running interrupted over a 33 year period in Mogale City, after careful consideration of the site (soil, residential areas, etc) and crop, for which Kikuyu grass was the crop of choice based on its high N removal (20 kg N/t of yield) and N needs (200-400 kg/ha) (Murphy, 2000). Extensive monitoring of the resources and most probable environmental acceptors which could contribute- or be affected by the agricultural use of sludge and effluent, was introduced in 1994. These included monitoring of the use of partially treated effluent for its moisture characteristics in the place of fresh water. This practice also required an exemption in terms of the National Water Act 1998 which place a duty on the municipality to return treated effluents to the catchments from where they originated. A major driver for Mogale City remained affordability, with the city having a large low income and unemployed population, and hence considering the potential burden on the taxpayer for high capital infrastructural expenditure.

Following the 1997 Guidelines, and as result of extensive consultation and research processes, an Addendum to the Guidelines were subsequently prepared and released in July 2002, which linked the handling and ultimate disposal to several other legislative and scientific fields, which were not considered with Edition 1. The explanatory Addendum clarified and simplified the interpretation of the SA sewage sludge legislative responsibility in the interim, and introduced revised (lower) values for Cd, Cu, Pb and Zn. The Addendum also stipulates that in addition to the aqua regia extraction previously used by municipal laboratories, the Toxicity Characteristic Leaching Procedure (TPLC) method also be included (Snyman et al., 2000).

This study examines the South African debate on the sustainability and ability to comply with guidelines in using sewage sludge as fertilizer and partially treated effluent as water source for the agricultural use in Kikuyu grass cultivation. The challenges involved in managing sewage sludge within the framework of the current South African sludge guidelines are best illustrated using Mogale City as a case study at two of the city's bulk wastewater purification plants.

The specific objectives were:

- to provide a general background to the history and current status of SA guidelines for sewage sludge disposal, from the perspective of a municipality
- to highlight key parameters from the evaluation of sewage sludge / effluent characteristics and volumes applied, soil quality, and groundwater contamination / quality;
- to assess the financial and commercial viability of instant lawn; and
- to indicate actual compliance with the current SA Guidelines, with regard to heavy metal content.

MATERIALS AND METHODS

A field monitoring program was established in 1994 at two bulk wastewater purification plants in Mogale Citysludge application to instant lawn farmland was incorporated: the Flip Human [F/H WCW] (altitude 1640 m, 26.18285oS, 027.77349oE) and Percy Stewart [P/S WCW] (altitude 1540 m, 26.07438oC, 027.72700oE). The climate is that of summer rainfall with an average annual precipitation of about 750 mm. A total surface area of approximately 136 hectares land is utilised for irrigation purposes.

The water analysis were done according to 'Standard Methods' (APHA, AWWA, WEF, 1995) as approved by the South African Bureau of Standards (SABS), and quality control checks performed using an (external) inter-laboratory water check proficiency system. The soil and sludge metal analyses were done according to the Agricultural Laboratory Association of SA (AGRILASA) method by the Institute for Ecological Rehabilitation, which quality control checks are performed with the International Soil Analytical Exchange (ISE) - Wageningen, Netherlands.

The study evaluated the following resources which would most probably impact or be affected by the sludge application: irrigation water quality, sewage sludge quality and anaerobic digester performance, water and sludge volumes, ground water quality, soil characteristics and a financial assessment of the instant lawn practice.

RESULTS AND DISCUSSION

1. Irrigation Water Quality

According to the SA Water Quality Guidelines (1996) for irrigation water standards, the effluent quality from both WCW generally improved in quality during the period 1998 – 2004, but most values exceed those of the irrigation standards. The quality of the effluent does not impact negatively on kikuyu cultivation. P/S WCW: A negative trend in effluent quality was observed for the following parameters: nitrate (high of 9.42 mg/l as N), phosphate (high of 13.1 mg/l TP), electrical conductivity (high of 11.5 mS/m) and TKN(high of 38.6 mg/l as N). An improvement in effluent quality was found in terms of suspended solids, total dissolved solids, total alkalinity, chloride, calcium, magnesium, sodium, chemical oxygen demand and fats, oil & grease. In general an overall improvement in effluent quality is apparent, however, concern is raised on the increases in phosphate,nitrate and salinity. F/H WCW: A negative trend in quality was observed for the following parameters: electrical conductivity (increased to 84.0 mS/m), suspended solids (highest at 123 mg/l), ammonia (highest at 14.35 mg/l as N), nitrate (4.29 mg/l as N) and TKN (highest at 19.92 mg/l as N). TDS and Mg remained constant during the study period, while an improvement in effluent quality is observed in terms of alkalinity, calciumCOD, fats, oil & grease, sodium, chloride and phosphate. In general, the F/H effluent is of better quality when compared to the P/S WCW.

2. Sludge Characterisation

According to the classification guidelines of sewage sludge to be used or disposed of on land, the sludge produced by the F/H and P/S WCW are classified as Type B sludge. Crop types that may be fertilised with sewage sludge and other methods of utilisation or disposal, include instant lawn cultivation with the following Restrictions applicable:

Application only with planting and during the period subsequent to harvesting and prior to the next growing season in order to minimize sewage sludge coming into contact with crops to be harvested; and
No subsequent selling or alienating of sludge or any mixture containing such sludge is allowed by the user.

Anaerobic digester performance and sludge quality

P/S WCW: The type of sludge referred to is that of primary sludge (withdrawn from the primary clarifiers) and humus sludge (withdrawn from the secondary humus clarifiers). The sludge is stabilised in three unheated, mechanically mixed, totaling a capacity of 10 250 m³. The digested sludge (19.22 ton dry sludge/d) from the anaerobic digesters is irrigated on the nearby instant lawn farmland (70 ha instant lawn and 18 ha greenhouses). An average hydraulic retention time (HRT) of 31 days is maintained. The average organic loading rate (OLR) applied was 1.38 kg VS/m3/d with an average sludge production of 343 m3/d. Average VFA removal for 2004 s 11%, with a VFA: Talk ratio of 0.51.

F/H WCW: Primary sludge is discharged to three anaerobic digesters and thickened waste activated sludge feeds to a fourth digester. These digesters are mixed (biogas) and heated, with individual capacities of 4 290 m³, operated at an HRT of 25 days. The digested sludge (29.44 ton dry sludge/d) from the anaerobic digesters and the overflow water from the sludge thickeners are disposed as liquid fertiliser to holding dams on the farmland (65.6 ha). From the central pump station at the digesters, the mixture is pumped to a booster pump station from where it is pumped to the instant lawn farm. The average organic loading rate (OLR) applied was 1.79 kg VS/m3/d, with an average sludge production of 774 m3/d. Sixty four (64)% VFA removal was achieved during 2004 (compared to the previously reported 46% for 02/03), with the VFA:Talk ratio being 0.60.

The digested sludge applied to land has the following physio-chemical characteristics The sludge pH in general remain between 7.01 – 7.36 (P/S) and 6.03 – 7.83 (F/H), with alkalinities varying between 1 434 – 11 228 (P/S) and 876 - 4002 (F/H). Since heating and mixing was reintroduced in 2000, the alkalinity stabilised considerably. TS vary between 2.4 – 9.9 and 2.05 – 6.7 for the two works. The average P (as ortho-phosphate) and N (as TKN) discharged during 2003-2004 are 62.0 - 1510 mg/l (P/S), and 151 - 553 mg/l (for F/H). The heavy metal content of the digested sludge is also of concern in land application and is depicted in Table 1. The digested sludge composition is typically of wastewater plants receiving a mixture of domestic and industrial effluent (40-48% industrial contribution).

When compared to the 1997 Guidelines for sludge (as amended 2002), the most recent (2004) sampled F/H sludge comply to all criteria, with the exception of Pb (121.93 mg/kg) which increased from 66.25 mg/kg in 2003. P/S complied during 2004, with the exception of Cu (134.43 mg/kg) which decreased from 570.25 mg/kg in 2003, Pb (227.38 mg/kg) which increased from 201.0 mg/kg in 2003. The source of the non-complying metals, Pb and Cu, has been traced to metal-finishing and tannery industries, which were required to address these problems. For both plants' sludge, As and Se did not comply in 2003 but are within the criteria requirements in 2004. Of concern, is the increase in Cd in both plants' sludge from 2003 – 2004 (1.0-.5 to 12.5 and 12.6 mg/kg), against a criteria of 15.7 mg/kg. This metal has a relatively high mobility in soil and considered to be the element most likely to limit sludge application to land (Korentajer, 1991) and will be monitored on a more regular basis.

Table 1a: Inorganic content in sludge for F/H WCW, tabled against the 1991 / 1996 SA standards.

Metal	Maximum permissible metal and inorganic content for 1991 (mg/kg)	Sludge criteria 1997 as amended 2002 (mg/kg)	Sludge Analysis Flip Human Instant Lawn Farm (mg/kg) 2003		Sludge Analysis Flip Human Instant Lawn Farm (mg/kg) 2004	
			Total	Available	Total	Available
Cadmium	20	15.7	1.00	0.20	12.52	0.58
Cobalt	100	100	17.25	1.80	9.28	2.46
Chromium	1 750	1 750	215.25	0.80	33.83	2.40
Copper	750	50.5	93.00	1.00	20.42	4.06
Mercury	10	10	N/D	N/D	N/D	N/D
Molybdenum	25	25	N/D	N/D	N/D	N/D
Nickel	200	200	131.25	15.90	23.85	30.02
Lead	400	50.5	66.25	10.10	121.93	37.54
Zinc	2 750	353.5	163.50	62.98	61.33	522.60
Arsenic	15	15	116.75	35.50	7.07	0.60
Selenium	15	15	21.75	7.30	5.13	0.48
Boron (mg/l)	80	80	N/D	< 0.010	N/D	0.06
Fluoride (mg/l)	400	400	N/D	12.214	N/D	1.55

Table 1b: Inorganic content in sludge for P/S WCW, tabled against the 1991 / 1996 SA standards.

Metal	Maximum permissible metal and inorganic content for 1991 (mg/kg)	Sludge criteria 1997 as amended 2002 (mg/kg)	Sludge Analysis Percy Stewart Instant Lawn Farm (mg/kg) 2003		Sludge Analysis Percy Stewart Instant Lawn Farm (mg/kg) 2004	
			Total	Available	Total	Available
Cadmium	20	15.7	1.50	0.30	12.62	0.79
Cobalt	100	100	10.50	1.30	8.18	0.74
Chromium	1 750	1 750	538.50	5.00	62.68	5.62
Copper	750	50.5	570.25	8.50	134.43	242.30
Mercury	10	10	N/D	N/D	N/D	N/D
Molybdenum	25	25	N/D	N/D	N/D	N/D
Nickel	200	200	154.25	21.90	42.15	50.47
Lead	400	50.5	201.00	30.10	227.38	209.65
Zinc	2 750	353.5	143.75	43.72	114.35	530.00
Arsenic	15	15	116.75	50.50	7.02	0.86
Selenium	15	15	25.75	4.10	4.52	0.32
Boron (mg/l)	80	80	N/D	<0.010	N/D	0.12
Fluoride (mg/l)	400	400	N/D	2.414	N/D	0.670

3. Water and Sludge Volumes

At the P/S WCW, an average of 1 811 m3 water per day are being irrigated onto available farmland (allowable volume being 1 900 m3/d), varying between 317 to 470 m3/day over the past 6 years of operations. At the F/H WCW, an average of 1 559 m3 /d are being irrigated onto available farmland. An average of 776 m3 sludge /d are being disposed of. The digested sludge production is calculated at 19.22 and 29.44 ton TS/day, respectively for P/S and F/H WCWs. The respective sludge application to land is conducted at a loading rate of 50.29 and 69.74 ton TS/ha/year, which poses serious limitations in terms of the allowable limits placed on this extent of application.

4. Groundwater Quality

P/S WCW: Accordance to the classification system for the assessment of the suitability of water for potable use (South African Standard Specification Drinking Water, 241:1999, 4th Edition, SABS),the data show that the majority of analyses comply with Class 0 standards, with the following exceptions that comply with Class I and II limits: EC (73.0-96.1 mS/m, TDS (645 mg/l), total hardness (22.53-10.91 mg/l as CaCO3, turbidity (0.6-2.49 NTU), Mg (33.46 mg/l), nitrate (7.67-9.36 mg/l as N). An overall stability is noted when compared with previous year's results, with the exception being the turbidity and nitrate concentrations, as well as the microbiological counts which are increasing

F/H WCW: this plant's underlying groundwater quality complies mostly with Class 0 standards, with some limited exceptions: Color is observed in all the boreholes, total hardness (42.83-117.15 mg/l as CaCO3) – but still within acceptable limits as many cities allow for a final water total hardness of up to 150 mg/l CaCO3, turbidity (1.55-22.75 NTU), Fe (0.02-0.04 mg/l); Mn (0.0 mg/l), ammonia (0.42 mg/l as N), nitrate (19.49 mg/l as N), indicator organisms (total plate count, total coliforms, faecal coliforms, Escherichia coli and faecal streptococci) in all the boreholes are indicative of contamination, at levels where significant and increasing risk of infectious disease transmission are expected, in some cases exceeding Class II standards. An overall improvement in water quality is noticeable when compared with previous year's results, with the exceptions being the turbidity, nitrate and microbiological quality.

5. Soil Characteristics and Quality

P/S WCW; The mean pH of the soil has increased slightly from 6.55 to 6.61 and is within the optimum range for enhanced soil fertility. Similarly, the base saturation has also decreased slightly to 70.54%, which is a primary indicator for expected or manifested soil pH fluctuations. The cation ratio for the latest soil samples are 100 Ca/S: 100 Mg/S : 100 K/S : 100 Na/S = 15 : 1 : 1 : 2 (the ideal ratio being 65 : 25 : 8 : 2). In this case the calcium, Mg and K levels are too low. The electrical conductivity of 83 mS/m is slightly higher than the preferred range of 15-35 mS/m. This electrical conductivity value is, however, acceptable for Kikuyu grass production (the maximum being 80 mS/m).

F/H WCW: he pH remained constant at 4.91 to 4.90 and is still within the natural expected range of 4.4 - 5.5. It is not foreseen that the pH will increase noticeably in future since the base saturation of the soil is fairly low at 32.0%. The cation ratio for calcium, magnesium, potassium and sodium as determined through the current analysis is 4 : 1 : 3 : 2. This does however, not reflect the ideal ratio which should be 65 : 25 : 8 : 2, which substantiates the need to increase the calcium and magnesium levels.

For both plants, it is observed that Fe and Al has increased, whilst the rest of the metal anions have remained fairly consistent and there seems to be neither major accumulation due to mineral migration nor any immediate pollution risk.

INSTANT LAWN - COMMERCIAL AND FINANCIAL ASSESSMENT
Kikuyu grass is cultivated on a total land area of 70and 65.6 ha, respectively for P/S and F/H WCW. The farming operation runs continuously for 12 months a year, with peak seasons being October – February. Grass is actively harvested 8-9 months of the year, with low to zero harvest periods over the winter seasons. Digested sludge is applied throughout the year on a rotational basis, receiving 9 – 13 applications during the 12 months season. Sludge application to a specific area (to be harvested) is terminated 5-6 weeks before harvesting. Effluent application occurs up to one day before harvesting, since cutting and loading of dry sods tend to break more easily. Kikuyu grass is removed 1 – .5 times per annum, corresponding with the optimal growth cycles in the more protected environment - climatically (P/S) and lower growth and yields under the harsher conditions of F/H farmland. Grass cutting however, takes place on a regular basis, covering the total farm area every week during summer time and only when needed in winter time. The results from previous field analysis showed that application of sludge in the liquid state is attractive because of its simplicity and no dewatering is required as pumping can transfer the liquid sludge. Recommended irrigation methods include sprinkling and furrow irrigation. Typically, large-diameter, high-capacity sprinkler guns are used to avoid clogging problems. Disadvantages of sprinkling to take note of include power costs of high-pressure pumps, contact of sludge with all parts of the crop, possible foliage damage to sensitive crops, potential odors and vector attraction problems, and potentially high visibility to the public.

Table 2: A summary of general expenditure, income, lawn cutting and lawn cost (actual and projected) over the period July 2002 to June 2006

PARAMETER	2002 (actual)	2003 (actual)	2004 (projected)	2005 (projected)	2006 (projected)
Salaries and allowances* (€)	23,330.02	28,621.34	28,127.05	60,191.81	64,405.21
Overtime (hours)	2,220.00	2,548.00	2,748.00	2,505.00	2,600.00
Overtime (€)	6,443.24	7,526.77	10,489.08	10,231.27	11,362.90
Vehicles leasing (€)	9,725.19	10,697.61	11,767.25	12,943.92	14,238.34
Vehicles maintenance (€)	8,137.10	8,950.81	9,845.78	10,830.40	11,913.40
Operational maintenance (€)	14,730.13	17,676.05	19,443.55	21,387.97	23,526.80
Electricity (€)	6,773.06	75,255.86	8,361.80	9,197.98	10,117.78
Total expenditure (€)	**69,138.73**	**80,998.21**	**88,034.51**	**124,783.34**	**135,564.43**
Instant lawn removed (m^2)	428,197.00	528,408.00	629,105.00	901,718.00	1,192,416.00
Total income (€)	**61,095.11**	**91,783.03**	**120,201.20**	**189,069.90**	**275,172.92**
Cost (€/m^2)	0.16	0.15	0.14	0.14	0.11
Selling (bulk) price (€/m^2)	0.14	0.17	0.19	0.21	0.23

Exchange rate used: 12/9/2004 (1€ = R8.06)
** 1x supervisor, 2x tractor drivers, 3x general workers*

In 200-2004, kikuyu grass retailed at between € 0.55 (undelivered) and € 1.05 (delivered) per m2. Whilst sludge handling was costing the municipality in the order of € 70 000 pre-2002, a break-even point was reached after 2002, with increased profiting from 2003 as the demand for instant lawn grows and the quality of instant lawn improves. At a total wastewater treatment cost of € 0.2 /kl (8 760 Ml/a for F/H WCW) and € 0.12 /kl (7 300 Ml/a for P/S WCW), sludge handling contributes to 8-10% of the total treatment cost.

CONCLUSIONS

The National Water Act No 36 (1998) requires all water users to take extreme care and responsibility of the environment and water resources, which include the assessment of disposal practices and its impact on the environment. Following the release of the 1997 "Guidelines for the Permissible Utilisation and Disposal of Sewage Sludge", an expanded monitoring program of sludge, effluent, soil, groundwater, and related plant performances was implemented by the municipality of Mogale City. The results from this study show that the Mogale City sludge handling practices are more of an asset (soil enrichment, affordability, job creation), whilst the possible liabilities (possible migration of contaminants, groundwater quality) are closely monitored. The current method of disposal, however, still compares favorably with alternative cost-ineffective, more complex methods of sewage sludge handling. It is therefore recommended that the current practice be continued, and that environmental risks evaluation continue by annual assessment/expansion of the existing program.

Future and separate studies will include microbiological quality of sludge, effluent and soil, the need to replace partially treated effluent with final effluent, and point source management of heavy metals (industries specifically) which negatively impacts on sludge quality. A cost benefit analysis and comparison between a municipal managed farmland (based on bulk sale of lawn at cost price), versus a completed out-contracted farmland on a rental/lease basis, have also been completed, considering the management of risks, liabilities, assets and economics associated with each practice. A need for clarity on the determination of inorganic constituents of sludge have been identified as a future need to be addressed by the steering committee of the Sludge Guidelines, since a lack of conformity in the methodology exists.

On a broader national level, the sludge debate is continuing, with the majority of municipalities finding difficulty to comply with the national ambitions, have limited resources and prospects, and hence, demands further research and guidance from government and the public authorities, in attempt to reach final agreements on various issues:

- cost of compliance and drawbacks of limiting sludge handling options, against the reality of decreasing OPEX and CAPEX for new infrastructure and maintenance in the municipal sector;
- scientific and analytical methodology, especially with regard to heavy metals;
- the political emphasis on recycling and reuse of nutrients as part of sustainable development;
- economic benefits of using sludge and effluent in agriculture, in place of fertilizer and fresh water.

ACKNOWLEDGEMENTS

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Market of Opportunities

On Tuesday afternoon, October 5th 2004, the International Water Conference was invited by the Berlin water company "Berliner Wasserbetriebe" to a “Market of Opportunities”. Wasserbetriebe hosted an exhibition and communication forum, where all participating cities as well as interested institutions and enterprises from Berlin got the opportunity to present themselves with a stand and to initiate discussions on ideas, best practice, innovations, projects, and cooperation opportunities with partners form other cities. .

More than twenty exhibitors took the chance to host a stand and to illustrate activities regarding the water sector – both representatives from partner cities around the world and institutions from Berlin, among them the following institutions:

from abroad:

- Ain Shams University, Food Department, Faculty of Agriculture, Cairo, Egypt
- Belgrade Waterworks and Sewerage, Belgrad, Serbia and Montenegro
- Catholic Relief Service , La Paz, Bolivia
- Wasserwerk - Wienkanal, City of Vienna, Austria
- Water and Waste Water, City of Windhoek, Namibia
- Dr. Abdelkarim Asa’d, Ramallah, Palestine
- Joburg Water, Johannesburg, South Africa
- Programa Universitario de Estudios Sobre la Ciudad, Universidad Nacional Autonomia de Mexico, Mexico City, Mexico
- Shanghai Municipal Development and Reform Commission (SHDRC) and Shanghai Municipal Water Authority, Shanghai, China
- Veolia Water, Prague, Czech Republic

from Berlin:

- Senate Department for Economics, Labour and Women’s Issues, Berlin, Germany
- InWent Capacity Building International gGmbH, Berlin
- BWB Berliner Wasserbetriebe & BWI Berlin Water International
- Kompetenzzentrum Wasser Berlin (KWB)
- Veolia Water, Berlin
- Engineering Company Kraft, Berlin
- erha consulting group, Berlin
- Pigadi GmbH, Well Services, Berlin
- Umwelttechnik Dr. Bartezko GmbH, Berlin
- Utt-Umwelttechnologietransfer GmbH, Berlin
- WASY Gesellschaft für wasserwirtschaftliche Planung und Systemforschung mbH, Berlin

The stands showed a high variety of projects, activities and best practice to learn from. So, the Berliner Wasserbetriebe installed their "Water Bar" as a practical example of an innovative product.

Next to the exhibitors around 150 interested people and representatives of the press visited the exhibition and used this opportunity to generate contacts, to discuss possible forms of cooperation, to build up networks and to foster existing contacts. Even if in the time available for coming together was limited, the participants succeed to initiate first contacts and to make first arrangements for further cooperation and exchange. The diversity in background, conditions and ideas was very fruitful to this dialogue.

Panel Discussion – Public Private Partnership in the Water Sector

Proceedings of the Panel Discussion

Eighty people attended the evening session on October 5 when a panel – Volkmar Strauch, Permanent Secretary, Senate Department for Economics, Labour and Women's Issues; Dr. Annette van Edig, Water Advisor to the Federal German Ministry for Economic Cooperation and Development (BMZ); Prof. Dr. Asit K. Biswas, President of the Third World Centre for Water Management; Prof. Dr. h. c. Dr. Ing. Denis Goldberg, Advisor to the Ministry of Water Affairs and Forestry, Republic of South Africa, Director of Community H.E.A.R.T.; Dieter Ernst, Chairman of the Board of Berlinwasser International; Reinhold Hüls, Managing Director, Veolia Water Germany; Myriam Constantin, Deputy Mayor of Paris; and Wallace Mayne, Manager Public Affairs, Johannesburg Water (PTY) Ltd. – engaged in a spirited discussion of 'Chances and Examples of Public-Private Partnership in the Water Sector'. The moderator was Dr. Eckart D. Stratenschulte of the European Academy, who has our sincere thanks for the excellent location, where we also had the opportunity to show 'Thirsty Planet', produced by Deutsche Welle.

Permanent Secretary Volkmar Strauch opened the discussion and outlined five points: 1.) There is no life without water. Providing access to safe drinking water is a basic task of the state. 2.) Fresh water is scarce. Conflicts arise over it. Now: should the state handle water problems itself or should it perform only a regulating function? 3.) Clean water is expensive. That leads to the question of who should pay for it: the individual, the community, the state or a combination of all of these? Can it be done through taxes, quotas or subsidies, or based only on market principles? Most other goods can be substituted, but in the case of water there is no alternative. 4.) Water is also influenced by cultural experiences and convictions. 5.) What is the difference between a state monopoly and a private proprietor with regard to water sources, purifying water, and other services? What services can be offered by the private sector and what must remain under the supervision of the state? There are different ways to make investments: on a private basis (also cooperatives), on a public basis, or a combination of both with different percentages. And if there is a private contribution, which part should it provide? Investment, production of the equipment or operation and management? One thing seems to be clear: The higher the contribution of the private sector, the stronger the state's role should be.

The panellists were in agreement on the main issues. Mr. Hüls of Veolia Water Germany stressed: Water is not a good that should be given away without any controls in place. In his opinion, the supervising function must be performed by the state, whereas operation and management should be in the hands of the private sector. Basic features are necessary in a public-private partnership. We must always consider the strength of the private as well as that of the public sector. With regard to duration, our action is medium- and long-term and consequently requires the building of a trusting relationship with our customers and the communities where our facilities are based. This long-term commitment means that we can apply technically innovative solutions tailored to our customers' needs and dedicated human resources of high quality to improve service levels. What abilities does the private sector have? What risks can it take that cannot be taken by the public sector? The public sector must clearly define roles: Which roles is it willing to give to the private sector, and what obligations do they have to fulfil? How can this be monitored? There must be mutual respect, otherwise this co-operation will not work. The consortium of Veolia Water and RWE had to decide how to make investments in the future. A long-term contract was signed giving certain guarantees to the employees. This, for instance, was one of the private partner's tasks. Through the Veolia foundation new jobs can be created with social projects. The goal is to create 1,000 new jobs by 2006.

The two keynote speeches that followed (by Ms. Constantin of Paris and Mr. Mayne of Johannesburg) can be read in full length on the attached CD.

Other questions were addressed to the panel: Can public-private partnerships be a model for countries outside Europe? In his answer Prof. Goldberg said that water is a public good and a commodity. But history and culture determine the form used.

Is profit always a main issue and why is it good? Mr. Ernst declared that there are two advantages: One is the mixture of expertise and commercial orientation and the other the balance of interests: better service, better prices, plus profit, but still lower costs for the customer – these are all advantages.

Prof. Biswas said that first there must be a dialogue to answer the following questions: 1. Is the solution cost-effective? 2. Is it efficient? 3. Is it reliable? Before answers to these questions are found, it can only be called a dialogue of the deaf. However, results all over the world show it is different everywhere. No conclusions can be drawn from the situation in one part of the world for others. Even if you apply the same solutions, the results may be different. Solutions may even vary at different times. Take an example from Sri Lanka. There was a water supply, but 30% of households used it for bathing and washing and not for cooking and drinking. This shows that additional measures – i.e., information and training – are

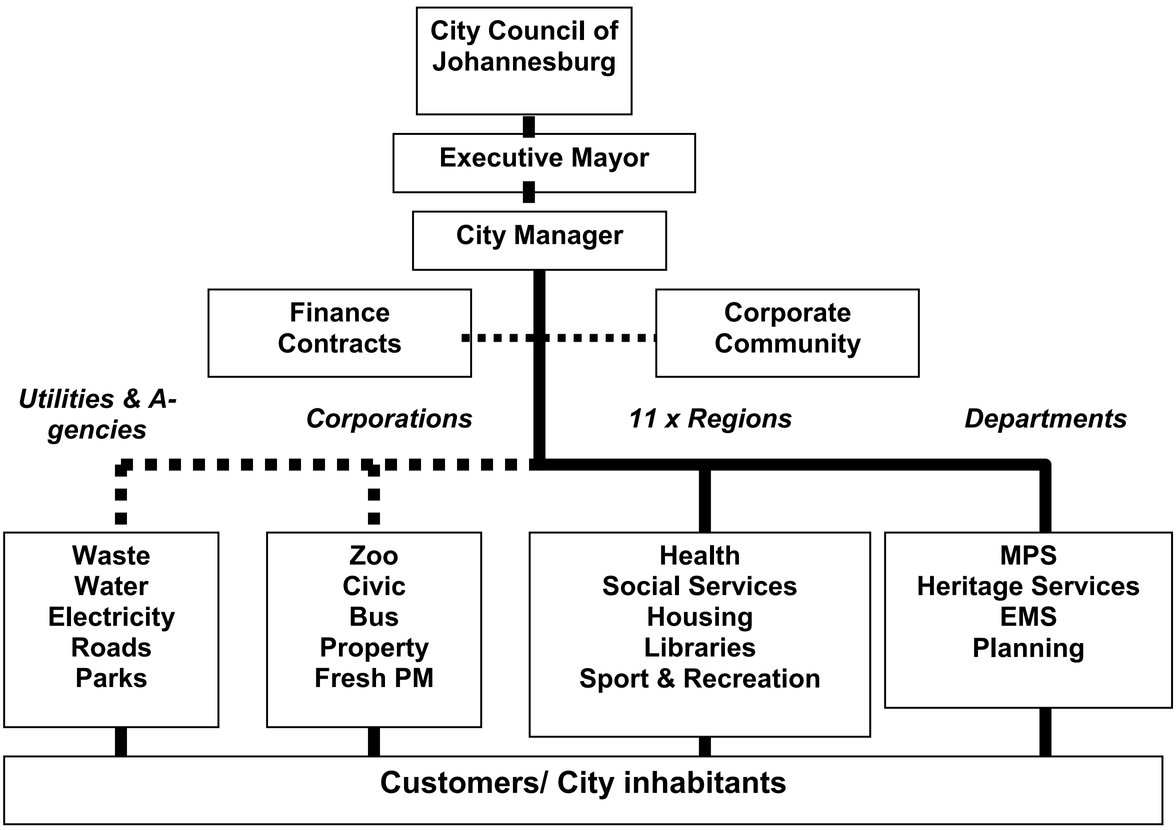
necessary to make the supply of water useful for people in the way it is intended. Investigation is necessary to find out what is needed. The world is very heterogeneous. There is always a need to be flexible in finding solutions. Some private companies have done a wonderful job – and some have been a failure.
Dr. van Edig added that millions of euros are spent for public-private partnership projects in 27 countries, with 95% having public management and only 5% a private management.
Prof. Goldberg commented that the private sector can play an important role. But what happens if they make losses? They demand of the state: „Please bail us out!" We have to look very carefully at the private sector claim that they are always more efficient than the public sector. A fundamental question is: Does the public sector have the people to monitor and control private sector water service providers? In South Africa we insist that the entire infrastructure should remain the property of the state, e.g., through the municipality. That implies a concession agreement. The municipality must have the sole right to set the tariffs and to ensure that all sections of the population are served. In South Africa this means that a stipulated volume of Free Basic Water must be provided. Ms. Constantin of Paris added a most important criterion, namely, that the contract between the municipality and the water service provider must provide for the municipality to have the right to cancel the contract without ending up in a situation of debt so severe that it is in effect locked into the contract even when the private sector partner is not fulfilling the terms of the contract.
In essence the question becomes that of finding the best solution to providing water and sanitation services quickly and efficiently in the specific circumstances of a particular country or region in relation to availability of capital, human resources and know-how, and the ability to pay interest on capital from revenues, etc.
Is good governance the problem? Prof. Biswas replied that the record of the public sector is sometimes as good as that of the private. Monitoring is necessary everywhere, no matter whether the private or the public sector is involved, Mr. Ernst concluded.

Presentation of the PPP Experience of Johannesburg Water
Wallace Mayne, Johannesburg Water (PTY) Ltd., South Africa

Johannesburg City Council in crisis prior to 2000

- The City has population of 3.2 million people with 900 000 in shanty towns
- It covers an area of 1 380 km^2
- It was divided into six municipal Councils
- The Revenue function was separated from the Service Delivery function
- The City experienced high levels of non-payment for services
- One third of population pays for the entire water and sanitation service
- The unaccounted-for-water [UFW] level was 42%
- The organisational structure of the City administration was highly fragmented and dysfunctional
- In 1997 the City experienced a severe cash shortage and so in 1999 the iGoli 2002 rescue plan was developed – based on formation of Utilities, Agencies & Corporations [UACs]

Institutional arrangement proposed in terms of the iGoli 2002 Rescue Plan



JW's MAIN FEATURES

Water networks:	9 800 km
Sewerage networks:	9 200 km
Wastewater works:	6
Reservoirs:	88
Water towers:	33
Water purchased:	1 200 m3/d
Wastewater treated:	940 m3/d
Number of employees:	2500
Turnover:	300 million EUR

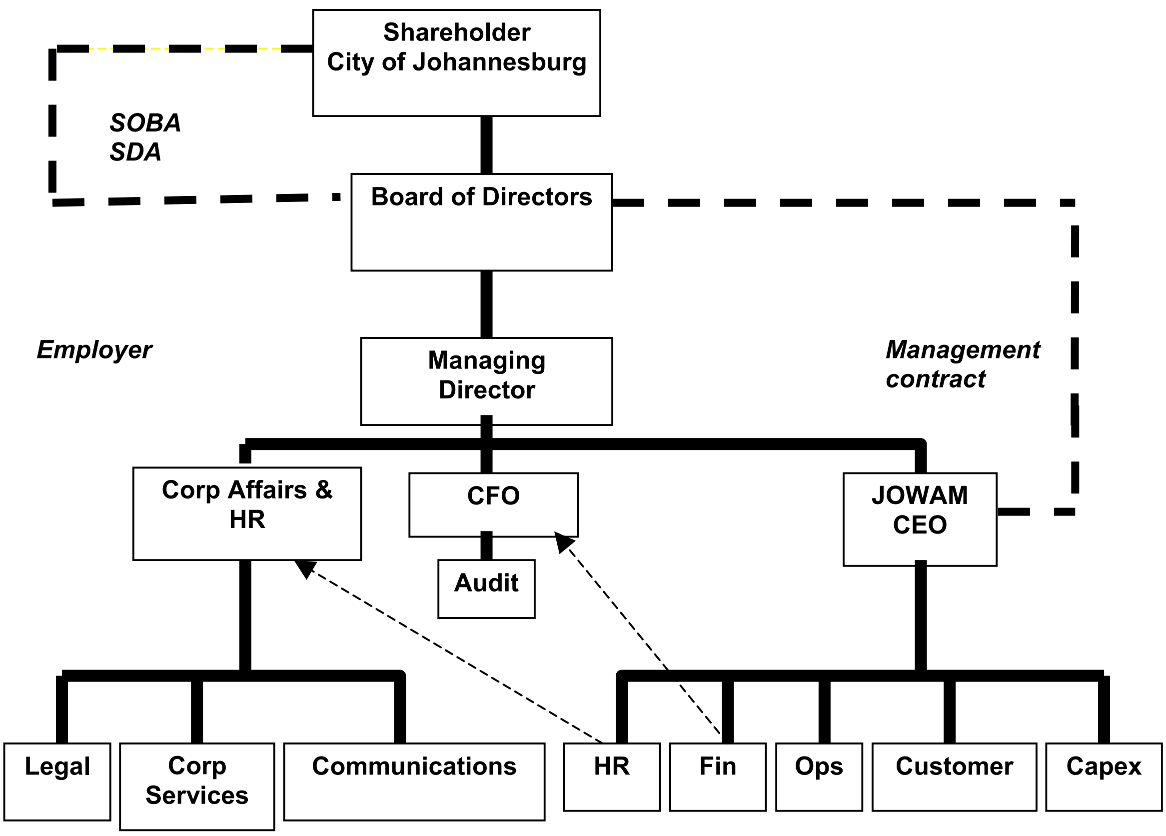
Why was a management contract chosen for the PPP arrangement?

- A Management Contractor is able to bring about speedy change in the utility
- A Management Contractor is able to install a ready-made management team
- A Management Contractor is able to bring the latest technology and methodsto the utility
- With a Management Contract the Council retains ownership of the utility

PROCUREMENT OF MANAGEMENT

- Contractor
- Pre-qualified seven joint ventures [JVs]
- Five JVs bid but two were eliminated on technical grounds
- The winning JV consists of Suez and SA black-majority-owned Companies

ORGANISATIONAL STRUCTURE OF JOHANNESBURG WATER



IMPROVEMENTS BETWEEN 2001 & 2004

Unaccounted-for-water:	42% ---> 35%
Sludge disposal compliance:	50% ---> 100%
Final effluent compliance:	85% ---> 95%
Spills at Wastewater Works:	700 ---> 150 pa
Drinking water compliance:	> 99%
Operating costs decreased by 10% in real terms	
Revenue collection from top customers:	56 ---> 95%
90% of calls answered in less than 30 seconds	

CONCLUSION

PPPs – Generic lessons

- Have to choose appropriate PPP
- Have to fairly allocate risk
- Able to improve services to customers.
- Contribute meaningfully to protection of environment.
- Develop affordable and sustainable services.
- Significantly reduce discretionary costs.

PPPs – Lessons for Johannesburg Water

- Must have strong political support and commitment
- Management and technical expertise provided by PPP is critical in turnaround strategy.
- PPP must develop new culture based on customer service, competence enhancement, accountability and innovation.
- PPP should control the Revenue stream

Presentation of the PPP Experience in Paris
Myriam Constantin, Deputy Mayor of Paris in Charge of Watersupply and Waste Water Management

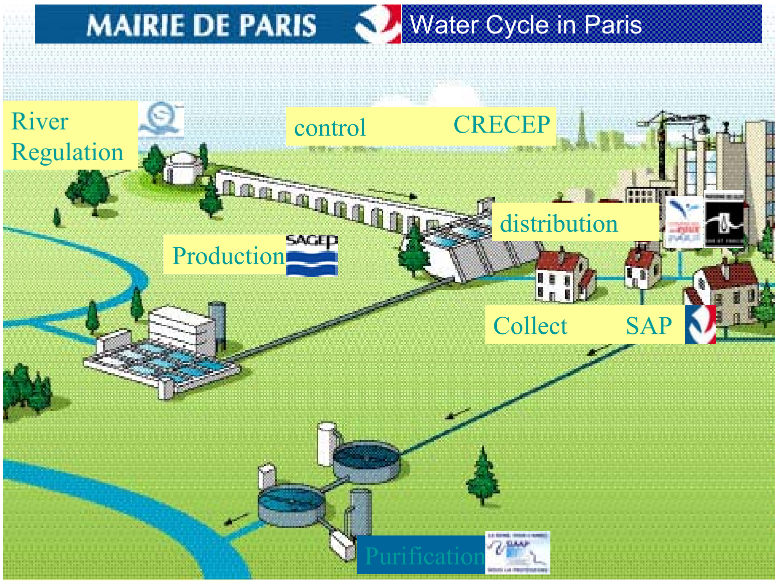
Ladies and Gentlemen,

it was a great pleasure for me to accept the invitation of the senate of Berlin to join the debate on Public Private Partnership. I am deputy mayor of Paris, a member of parliament and the person in charge of fresh water and sewage water.

I would like to contribute my knowledge on the management of public service in Paris essential for life that is the water in a frame of French and European context where the partnership of the public (that is the city of Paris) and the private sector is a current habit in a way of different configurations and, this is very important so far with priority of public decision and control.

In the following I would like to outline my perception of present developments in France and in Europe concerning the partnership between the public and the private sectors.

PARIS
In 2001 the City of Paris found a public authority which had been given away almost all the public services to private partners and this nearly in all possible legal forms permitted in France at that time.



First a brief presentation of water circulation in our city:

the regulation of rivers (to prevent inundations and guarantee supply at lowest water levels) which is executed since 1970 by a community of interests of the departments of the region ‘Ile de France’, a public entity (the „grands lacs de Seine“ – big lakes of the Seine) where we have elected representatives;

the waste water treatment, which is also executed since 1970 by a community of interests of the departments, called SIAAP, where we are also represented and to whom we have transferred the competence;

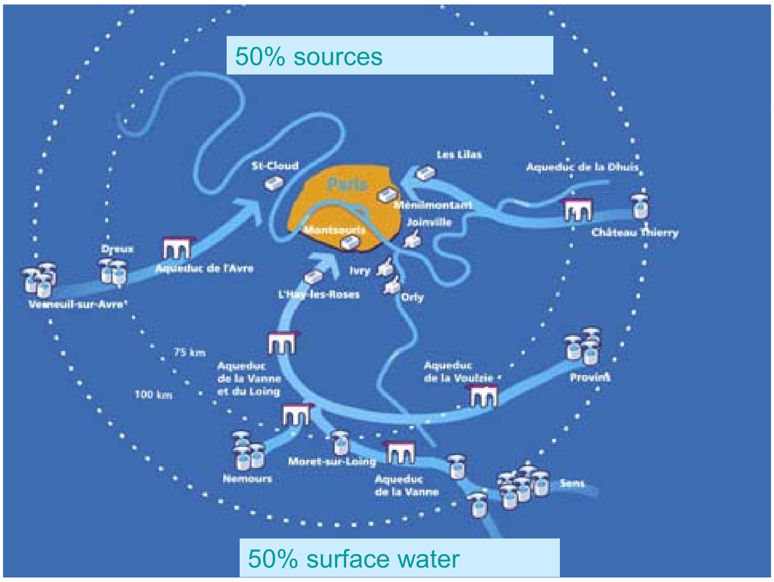
the SAGEP, a mixed economic society (société d’économie mixte, SEM) since 1987 of which the city holds 70 % for the production of water whereas 28 % are hold by private companies, who organise the water supply in Paris. In return they hold a license until 2011 the City of Paris;

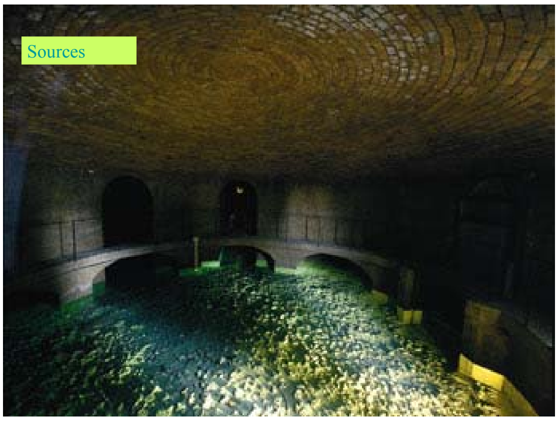
the water supply of the immediate areas and the banks of the river Seine (rive droite and rive gauche) in Paris is executed since 1985 by two private companies, the Générale des Eaux (Veolia-Group) and the Lyonnaise des Eaux-Suez,. These two companies have leaseholder contracts with the city of Paris;

a municipal service company with special budget for waste water disposal;

a municipal service company for analysing the water quality, which we transformed in 2003 into the CRECEP, an institution with self-administration and public structure.

All this shows a highly complexity of players who are institutionally and contractually bound to the City of Paris and who contribute to the public capacity in water supply.

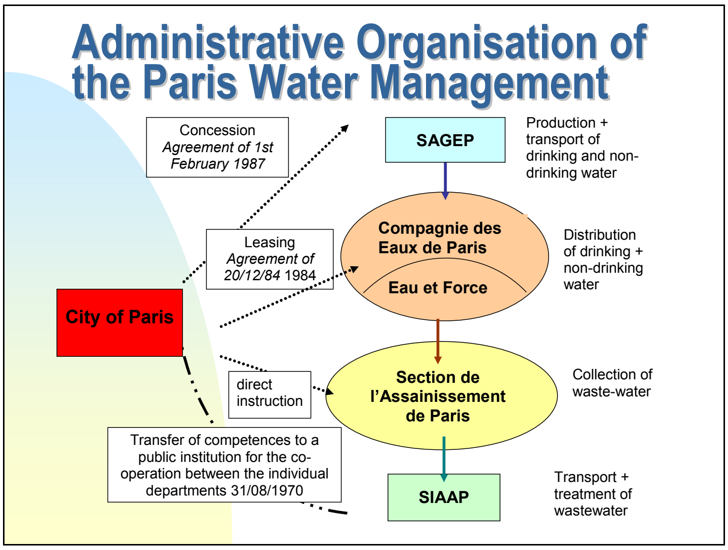




Data

- Water quantity produced in 2003 : **246 millions m3**
- Water quantity distributed to customers in 2003: **217 millions m3**
- Performance for Paris: **88,9 %**
- Number of clients: **93 000**
- Last population census in Paris reported **2,125 millions inhabitants**
- Price of water per m3 on 1st July 2004 = **2,2923 euro TTC**

Let me get back to the complex organisation of public services in Paris.



In this context I do not like to talk about the institutional links with the regional authorities that are the departments around Paris that are represented in the SIAAP and the "Grands lacs de Seine". They are not our subject today. I would like to tell you about the organisation of Public Private Partnerships in the public water services of Paris and the development of those partnerships under the current rule since 2001.

In France there are lease agreements and licenses that are fixed in contracts issued by the public sector. The public side controls their execution and the risks have to be taken over by the private operator. Without the concession the investments theoretically are much bigger and are carried out by the private partner, who tries to be profitable. In fact the contractual regulations are often an unsatisfactory trade-off. These two possible forms of a contract require, from our point of view, a strong public control which itself is based on a strong public ability to define the goals and the politically orientation.

When we build up the new municipal administration in 2001the City of Paris executed only an indirect and merely formal control of the water services through the annual activity reports of their delegates of SAGEP and the other water supply companies. These reports had been passed by the City Council of Paris. The daily operational, technical and financial control was carried out by the SEM on public expense. The SEM itself counted among its assets the two private companies (belonging to its administration board) which they had to control in principal and by the way to whom they sold the produced water. This mixture was criticised by the regional audit court and other auditing bodies. I am of the same opinion as the Mayor of Paris that this is neither for the benefit of the people from Paris nor of the consumers and the public interest.

The responsibilities of the city, the SEM and the two private companies were not clearly defined concerning exploitation, management and investments. The assets and circulating capital, their value and conditions were unknown to the city. The city did no longer amortise and consider the depreciation reserve as the water budget was dropped in 1987 when SAGEP was established. Finally the price of water, which was by the way lower than the average in France, was not based on a prior calculation and a schedule of assets thus it was not possible to evaluate the profitability of the service correctly.

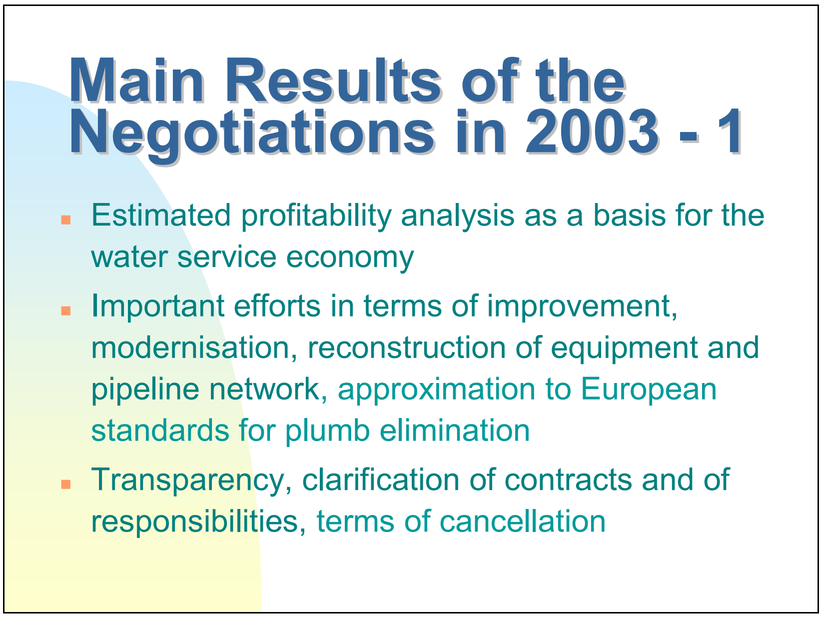
Even if the company was considered to be correct, it was impossible to evaluate its services and productivity. Water losses through leakages had been reduced but remain static on an alarming level. But above all we were forced to intensify the work on the water supply pipe work and installations to eliminate the lead in the public water pipes until 2013, which in fact would have taken 50 years, if we had stuck to the contracts.

These contracts and transfers of competences had been made without comparing any offers of compromise for a period of 25 years, which is a very long term. Add to this we had to handle another problem: the contracts had been composed imprecisely, there were no regulations concerning their termination in 2009 and 2011 neither the accounting of assets nor the restitution and the destiny of the employees. We were in a miserable situation.

Shortly, neither the city nor the population get their money worth within these cooperation agreements and nevertheless the contracts had to be fulfilled for many years. It was necessary to modify them by negotiating. And this is what we have done. In these long negotiations we found very competent and professional partners and I am appreciating that.

Nevertheless one of the first necessities was, and I like to underline this, to guarantee and to re-establish a strong public capacity for these negotiations. It took us two years to mobilise competent services of the city by strengthening them under a new organisation and by calling in experienced advice. It took us one year to negotiate and to sign additional agreements to the contracts.

We think that we were able to improve the situation of the Public Private Partnerships considerably.



The city regained direct control of the public water services. Especial budget on water was implemented. We have clarified the roles and responsibilities of the different parties.

The city has requested and gained many more investments, maintenance work, improvements in the organisation of the services and the elimination of lead until the end of the contracts in the year 2009.

Parallel to the negotiations we have asked the two private companies to let aside the capital of SAM and thus obtaining a higher transparency and deontology. This project is not completed yet.

Last but not least these actions are undertaken under the eyes of the Paris population harmonised with the commission for customer services, with more rights to intervene.

PUBLIC PRIVATE PARTNERSHIPS
According to my experiences in Paris as an elected representative and expert for local development regarding Public Private Partnerships, I have learned that it is important to avoid any ideological dogmatism a priori.

For the public side it is especially important to fix the advisability and the conditions of implementation of the Public Private Partnership. I especially emphasise the primacy of the public authorities, of the politics as they are the fundamental and legitimated representatives of the citizens and the society.

There may not be an ideological postulate that all public enterprises or those public enterprises, that are able to gain income, must be pledged to competition or be substituted by private offers. This is an internal decision to open public enterprises – especially local public enterprises – for competition. It must be a decision of the city and it must be possible to retract it. I am still waiting for the evidence that the private sector should outmatch the public sector. I think, in view of the matters of fact this postulate can not be hold up seriously.

Additionally, Public Private Partnerships imply a balance between the public and the private side. The primate of the political decision must go along with a substantial ability to analyse and order of controls and evaluation measures. As we have seen before, even a capital like Paris, could loose control over an important public business to the disadvantage of its population. Permanent efforts for a public evaluation are necessary based not only on the public administration, but also on laws, regulations, guidelines of the European Union and adequate bodies and evaluation structures. This ideal situation has not been reached – thinking of the well known forms of concessions, leaseholds and services of the Public Private Partners - in France in the last years. I am really concerned about the new forms of Public Private Partnerships that are propagandised under liberal pressure by some people in France, Europe and all over the world.

Even the European Commission showed their concern due to the amplitude of juridical instruments concerning the foundation of public private partnerships. They decided to publish a green book regarding this topic in order to remind on the high principals of transparency, call for tenders and equal treatment. Especially they draw the attention to a fake illusion of a diminishing public indebtedness.

Ladies and gentlemen, I have as much as you a great interest that Public Private Partnerships – where they exist – lead to an upgrade of public enterprises and a higher quality for the well being of the citizens and the community.

I thank you for your attention.

On-site Visits to Institutions and Enterprises in Berlin / Brandenburg

On the third day of the International Water Conference, October the 6th, 2004, the participants had the opportunity to visit innovative projects of various water institutions and enterprises in Berlin and Brandenburg. Three on-site tours were offered.

Special thanks are given to the tour leaders, who arranged the on-site visits and gave a lot of useful information which complemented the theoretical days of the conference perfectly:

- Tour A: Brigitte Reichmann (Berlin Senate Department for Urban Development), Katharina Teschner (Technical University Berlin), Marco Schmidt (Technical University Berlin)
- Tour B: Dr. Anton Peter-Fröhlich (Berliner Wasserbetriebe)
- Tour C: Mr. Prenzel, Christoph Sahlmann (Berliner Wasserbetriebe), Dr. Klaus Möller (UMD Möller & Darmer GmbH)

Tour A – Innovative Water Concepts : Process and Rainwater Management: Integrated runnoff management in Berlin - also in areas without sewer systems

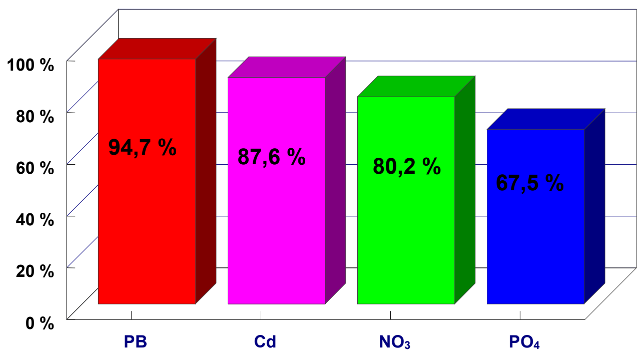
The participants visited two successful examples of substitute drinking water by process- and rainwater in buildings at Berlin-Adlershof and Potsdamer Platz. The project at the Institute of Physics of Humboldt University in Berlin-Adlershof features a combination of storm water management and energy saving. The DaimlerChrysler Area at Potsdamer Platz Berlin was built under very strict stormwater management regulations to protect the local surface water - the Landwehrkanal - from additional mixed sewer overflows during storm water events.

Brigitte Reichmann, Senate Department of Urban Development, Ecological construction, Berlin; Katharina Teschner, Department of Sanitary Engineering, Technical Univerity of Berlin; Marco Schmidt, Department of Applied Hydrology, Resource Protection, Irrigation and Drainage, Technical Univerity of Berlin

1. INTRODUCTION

Rainwater harvesting is becoming an important issue. More so because until 2020 50% of the world's population will live in cities. The increase of urban areas forces high priority on decentralized measures of rainwater retention. In four examples from Berlin implementation of different concepts of integrated runnoff management is shown.

There are two main goals of rainwater harvesting. One goal is to replace drinking water for toilet flushing and other purposes for which drinking water quality is not necessarily needed. The second goal is the retention of rainwater to reduce the sewer systems inflow in order to either avoid overload in combined sewers or reduce contamination in seperate sewers [3]. The following data demonstrates such positive effects. Figure 1 shows the reduction of nutrients and heavy metals as percentage of influx as a three years average, measured on research plots of the Technical University of Berlin. Figure 2 demonstrates the increase of phosphate retention due to the establishment of plants over the years after greening.



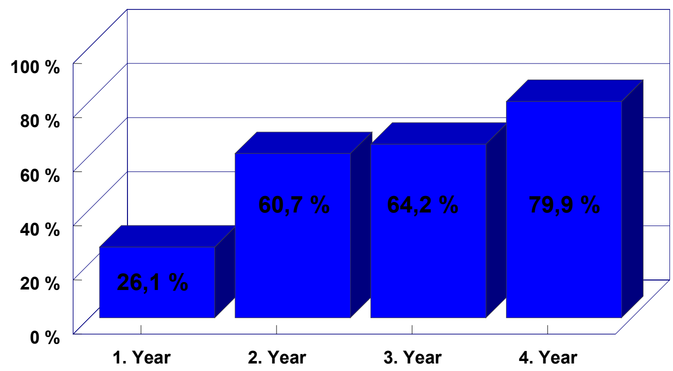


Fig. 1 + 2: Reduction of nutrients and heavy metals by greened roofs as percentage of influx [2]. Further data see also: www.roofmeadow.com/water_quality.htm

2. EVAPORATION BY GREENING ROOFS AND FACADES

Reduced evaporation and evapotranspiration is the main hydrological difference between urban and rural areas. Missing evapotranspiration increases the thermal radiation caused by higher surface temperatures of hard materials like concrete and the ability of such surfaces to store heat (Fig. 3). New innovative rainwater projects focus on the necessity of evapotranspiration rather than infiltration. The Cultural Center ufaFabrik in Berlin-Tempelhof is a site of various urban ecology projects (see: www.ufafabrik.de and also: www.id22.de) including an integrated rainwater management project. As a first measure, most of the roofs have been greened in 1983 to 85. In 1994, a rainwater harvesting system was integrated. Runoff of the green and the conventional roofs is collected as well as the runoff of the streets and is stored in a basement of a former waterworks station.

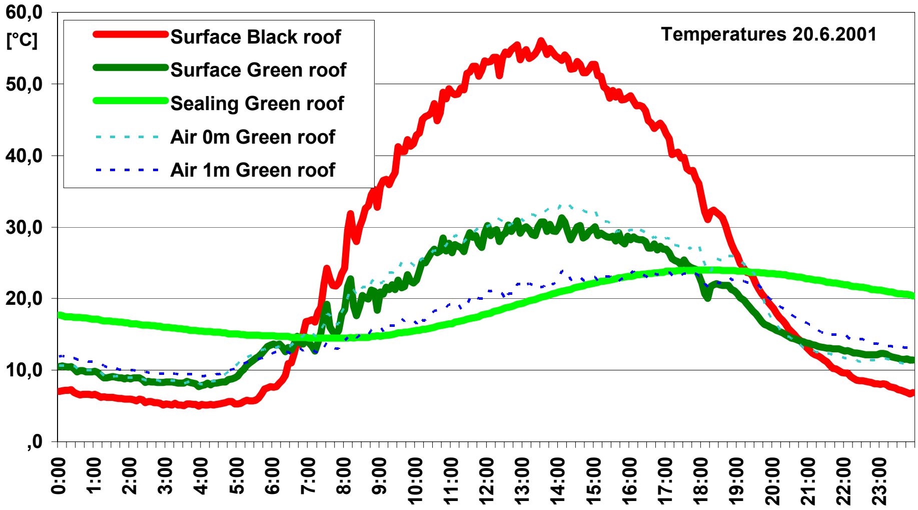


Fig. 3: Reduced surface temperatures of a greened roof compared to a conventional tarboard roof (Infra-red measurements)

The rainwater utilisation system has a total storage capacity of 240 m³ in two cisterns. This is equivalent to 40 mm or 6,7% of the annual precipitation. The system collects primarily "first flush" stormwater. The capture of pollutants and nutrients provides an increased ecological benefit. The collected rainwater is treated in a modified constructed wetland. It is then used to flush toilets and for irrigation.

Project data	UFA-Fabrik Berlin Tempelhof	
	storage capacity rainwater cistern	240 m³ (39 mm)
	total daily water use	6,3 m³ (1.04 mm)
	percentage of drinking water	36 %
	proportion of total precipitation used	72 % (simulation)
	reduction of nutrients and heavy metals	> 90 % (estimated)
	constructed wetland for rainwater treatment	25 m²

Tab.1: Project data UFA-Fabrik Berlin Tempelhof [3]

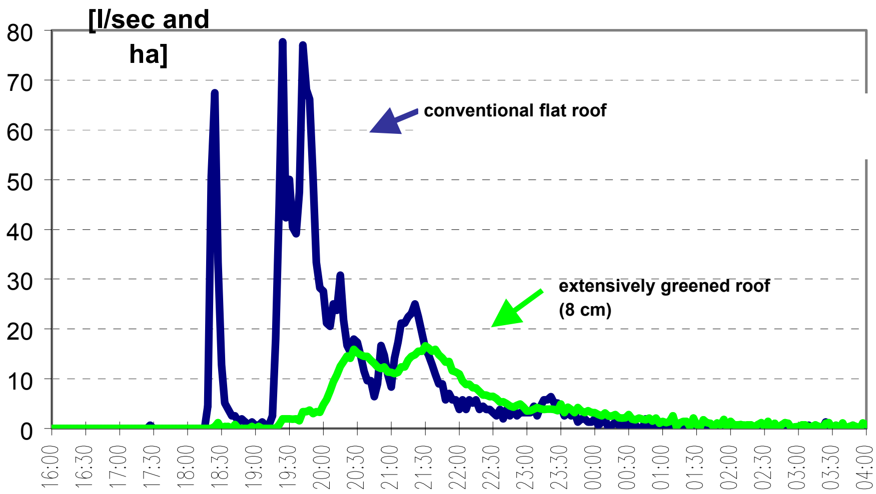


Fig. 4: Stormwater runoff, water retention and drain delay for greened roofs compared with tarboard roofs, 12.6.-13.6.1998 ufaFabrik Berlin-Tempelhof [2]

Measurements have shown that green roofs can evaporate 60 to 75% of the annual precipitation (in Berlin, average precipitation is 590 mm per year while potential evapotransipration is 660 mm per year). The intensity of stormwater runoff from greened roofs is 80% lower than from conventional flat roofs, depending on the soil layer and the saturation of the soil (Fig. 4) [1].

According to measurements made at the ufaFabrik in Berlin, extensive green roofs transfer 58 % of the radiation balance into transpiration during the summer months. The resulting cooling-rates are on average 300 kWh/(m² *a) in Germany. Hard materials in urban areas like concrete and bitumen roofs transform up to 95% of radiation balance to latent heat. As a result, air temperatures inside buildings also rise and lead to discomfort or increased energy consumption for climatization [4].

A new project, the Institute of Physics of the Humboldt University in Berlin-Adlershof features a combination of stormwater management and energy saving.

It is one of the Senate's Department (of Urban Development) urban environmental projects where potential applications for rainwater are observed with the focus on use of process water for buildings. A practical example is applied and will provide information towards sustainable housing and urban development.

The project of the architects Augustin and Frank, Berlin, combines natural cooling by green façades with technical adiabatic cooling systems. Both systems are supplied with rainwater. Rainwater is stored in five cisterns in two courtyards of the building. The plants which are irrigated with rainwater provide shade during the summer, while in the winter, the sun's radiation penetrates the glass front, because the plants have lost their leaves. In this project the water demand of the different plant species as well as the demand for the adiabatic cooling system will be monitored by the Technical University. Both the shade created by the plants and their evaporate cooling will influence the energy consumption of the building.

Stormwater events with heavy rainfall are managed by overflow to a small urban lake in the courtyard. No rainwater sewer has been constructed, the runoff is managed completely inside the building complex.

Project data	Rainwater management Potsdamer Platz, Berlin	
	extensive and intensive green roofs	44.000 m²
	storage capacity rainwater cistern	2 550 m³ (69 mm)
	artificial lake	13 000 m²
	constructed wetland for rainwater treatment	1 900 m²

Tab. 2: Project data Institute of Physics Berlin HUB - Adlershof [4]

3. HARVESTING AND UTILIZATION OF RAINWATER

The DaimlerChrysler Area at the Potsdamer Platz, Berlin, was built under very strict stormwater management regulations to protect the local surface water - the Landwehrkanal - from additional mixed sewer overflows during stormwater events.
The historic city centre of Berlin turned into the largest building site in Europe in the 1990s after being a wasteland after the wall had been built. Nowhere in Europe was the sealing of surfaces on an extremly large scale so visible.

In order to avoid overloading of the existing combined sewerage system, the building permit issued by the city council stated that the new complex could drain rainwater into the sewerage system at a rate of no more than 3 l/sec /ha or 1% of flows during storm events. To comply with this regulation, the Atelier Dreiseitl and the landscape architect Daniel Roehr implemented the following measures for the management of 23 000 m³ of rainwater which fall annually on this complex of 19 buildings:

- extensive and intensive green roofs
- collection of roof-runoff for toilet flushing and plant irrigation
- an artificial lake for rainwater retention and evaporation

12 % of the annual precipitation can be stored in four cisterns with a total capacity of 2 550 m³. The collected rainwater is used for toilet flushing and feeding the artificial lake in dry periods.
The artificial lake system covers a total area of 13 042 m². The level of the artificial lake can be varied by 30 cm, which corresponds to an additional storage capacity of 11% of the annual precipitation of the catchment area [3]. To reduce nutrients the rainwater going into the lake is passing a constructed wetland which is planted mainly with phragmites.

Tab. 3: Project data Potsdamer Platz, Berlin

Project data	Institute of Physics Berlin HUB - Adlershof	
	storage capacity rainwater cistern	40 m³
	adiabatic cooling systems	8
	planted and irrigated containers	151
	connected roofs	4700 m²
	pond in the courtyard	225 m²
	Stormwater retention of pond in the courtyard	180 m³

4. REFERENCES

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2 Köhler, M., Marco Schmidt, Friedrich W. Grimme, Michael Laar, Fernando Gusmão: Urban Water Retention by Greened Roofs in Temperate and Tropical Climate. IFLA-Congress 2001, Singapore.
3 Schmidt, M: Rainwater harvesting in Germany. Proceedings 3. Simposio da captacao da agua da chuva. Campina Grande, Paraiba, Brasil 2001.
4 Schmidt, M.: Energy saving strategies through the greening of buildings - the example of the Institute of Physics of the Humboldt-University in Berlin- Adlershof, Germany. Proceedings Rio3.com, Rio de Janeiro 2003

5. FURTHER LINKS

www.rio3.com/proceedings/RIO3_481_M_Schmidt.pdf
www.gebaeudekuehlung.de
www.tu-berlin.de/~Wasserhaushalt
www.augustinundfrank.de
www.dreiseitl.de

Tour B: New Decentralised Concepts of Wastewater Treatment: A large-scale test for separate treatment of urine, faeces and grey water – demonstration project in Stahnsdorf

The conference participants were offered a visit of the demonstration project for separate treatment of urine, faeces and Grey water in Stahnsdorf. In view of low interest (only two candidates expressed their interest) this tour did not take place. Anyway, further information can be obtained from the annex of the documentation and the CD.

Another example of innovative wastewater treatment is the demonstration project for new sanitation systems in a residential and office building in Stahnsdorf (Brandenburg), where a consequent separation and separate treatment of different wastewater flows (urine, faeces, grey water) and reuse / recycling of treated substances is realized. This new concept of ecological sanitation awarded an EU-LIFE grant. During the 3.5 year SCST project (Sanitation Concept for Separated Treatment), an office building and ten apartments located on the site of a wastewater treatment plant have been equipped with a sanitation scheme reproducing the hydraulic flow below.

For further information see the last page of the paper 'Vision of Advanced Decentralised Systems in Wastewater Management' by Boris Lesjean or

http://www.kompetenz-wasser.de/dt/projekte/proj_scst.htm .

Tour C: New Decentralised Concepts of Wastewater Treatment and Reuse Aspects: The sewage treatment plant Waßmannsdorf – Process Engineering for Wastewater Treatment and Reuse Options

The participants visited the Wastewater Treatment Plant in Berlin Waßmannsdorf (WWTP) where innovative technological solutions are implemented into practice. Since 1997 a part of the advanced treated wastewater from the WWTP Waßmannsdorf has been led in former drainage ditches through a lowland area south of Berlin. The project shows that a controlled discharge of advanced treated wastewater into a water cycle is generally a feasible method to enhance limited water resources.

Mr. Prenzel, Christoph Sahlmann, Dr. Klaus Möller

WASTE WATER TREATMENT PLANT WAßMANNSDORF
Owner: TELO Beteiligungsgesellschaft mbH &Co.
Objekt Kläranlage Waßmannsdorf KG
Operator: Berliner Wasserbetriebe www.bwb.deb

PROCESS ENGINEERING TECHNOLOGY:
Mechanical and biological treatment, biological phosphate removal in conjunction with nitrification and denitrification. In addition, providing the option to remove phosphates chemically by means of simultaneous precipitation. The digestion of sewage sludge takes place in specially constructed digestion tanks. Sludge which has been digested, de-watered in centrifuges and dried in drum driers is sent to be gasified at the secondary waste recycling centre SVZ Schwarze Pumpe.

TECHNICAL DATA
Purification rate: 169.000 m³ (dry weather)

PRIMARY TREATMENT:
Four revolving screeners, four grit chambers, ten rectangular tanks with a total volume of 22.000 m³ for preliminary treatment.
Secondary treatment:
Eight activated sludge tanks that have a fine-bubble surface aeration and have a total volume of 203.600 m³. Compressed air is provided by electrically powered turbo compressors.
Sixteen circular tanks with a total volume of 81.300 m³

SLUDGE TREATMENT:
two flotation tanks that have a through-flow rate of 315 m³ / h each, two excess sludge centrifugal thickeners that have a through-flow rate 78 to 100 m³ / h, six digestion tanks that have a volume of 8.000 m³ for sludge digestions, 4 de-watering centrifuges.
Utilisation of waste heat:
Three flue gas cleaning plants for biogas amounting to 30.000 m³ / day, three bubble-gas tanks with a total storage capacity of 11.000 m³

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