INFLUENCING URBAN WATER MANAGEMENT THROUGH LEARNING ALLIANCES A REFLECTION ON THE "WATER CLUB" PROCESS IN TEL AVIV, ISRAEL

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I. INTRODUCTION

City background

Tel Aviv covers an area of 500 ha, and has a permanent population of 386,000 people which increases up to 1 million people during week days when hundreds of thousands of commuters flow into the city from outlying communities. It is the financial and administrative centre of Israel located on the Mediterranean coast. The consolidated urban area surrounding Tel Aviv creates a metropolis of almost 2 million inhabitants. The city (more fully known as Tel Aviv-Yafo) is the workplace for more than 15% of the overall employed population of the country (of which some 65% are daily commuters). The annual GDP per capita is US$52,000 (three times the US$17,250 average for the whole population in the State of Israel). Dynamic population development within the city and surrounding conurbation, results in increasing water demands and production of sewage (380,000 M3/Day). There is a continuous pressure to provide services.

The major water issues in Tel Aviv are related to water scarcity, which is a typical of cities in arid countries. Industry is a minor user while the greatest demand results from intensive residential development. Water sources include: surface water,

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groundwater and desalinated sea water. The major proportion of drinking water (90%, 130 MCM per year) is supplied by Mekorot National Water Company. The other 10% is supplied by local wells. As a Government policy, more and more water is being supplied by sea water desalination and in the past 5 years new seawater reverse osmosis (SWRO) plants have come on stream. The policy is currently to provide 600 MCM per annum of desalinated water but in the near future it could be that some 80% of all potable water in Israel will come from desalination.

Figure 1
Source: (tba)

Agriculture is a major user of water, although this has reduced considerably in recent years. Agriculture is provided with both fresh water and tertiary treated effluent through what is known as the “Third Line” a large diameter pipe that transports treated final effluent to farmers in the south of the country. Increasing populations result in increased amounts of sewage and this, together with awareness of the water shortage has resulted in focused efforts to develop the best technologies for wastewater reclamation and reuse. In 2005 reclaimed wastewater constituted some 15% of the total water sources in the country. Israel now reuses more than 75% of its municipal effluents (some 400 MCM/year), which makes them the world’s highest consumer of recycled effluents and constitutes a result incomparably higher than in most other countries (e.g. 12% reuse in Spain, and <1% in EU). Israel has demonstrated world leading technologies and achievements in

this field and is recognised throughout the world as one of the foremost promoters of water re-use in agricultural irrigation developments systems.

Tel Aviv and neighbouring municipalities in the Dan Region Association of Towns collect wastewater transferred for treatment to the Shafdan (Wastewater) Treatment Plant (WwTP) operated by Mekorot. This provides secondary treatment for all the wastewater received and adds a further tertiary treatment stage using soil-aquifer treatment (SAT) technology. The Dan Region Reclamation Project at Shafdan is the largest wastewater treatment and reclamation project in Israel, reclaiming more than 140 MCM of wastewater a year. High quality reclaimed water produced by this technology is sold for unrestricted irrigation in the South of Israel (Negev), enabling the development of important agriculture home and export markets. The synergistic nature of this relationship between water provider, cities and farmers is indicative of the advances that Israel has made in water management over the past 30 years. Water is a strategic as well as a domestic necessity in Israel. Recycling of effluents is not only a common practice but also very well controlled.

Box 1 Mekorot - a world leader in desalination and water reclamation

Mekorot is the Israeli National Water Company and is responsible for the provision of water supplies and wastewater treatment. Each year Mekorot delivers over 1.5 billion cubic meters of fresh and treated water in Israel, representing 80% of the country's drinking water supply and 70% of its overall water consumption.

Mekorot supplies water to approximately 5,000 intermediary water providers, including municipalities, regional associations, agricultural settlements and industrial consumers.

Mekorot is one of the world's most technologically advanced water companies and with 70 years of innovation has become a world leader in desalination, water reclamation and water engineering.

One of the company's greatest achievements has been the development and operation of a nationwide water network that allows it to move water rapidly from freshwater sources and treatment facilities to water distributors and end users.

Mekorot operates the Shafdan Wastewater Treatment Plant (WwTP) on behalf of the Dan Region of Towns and is responsible for the delivery of treated final effluent to the farmers in the south of Israel for the irrigation of their crops. By this process, the Dan Region provides 80-100% of the water for agriculture in the northern part of the Negev Desert, which constitutes 40% of all water supplied to the south of Israel.

Wastewater for recovery is provided by small local communities throughout Israel In general these are recovered from Municipal WwTP but there are trends now towards other technologies, such as membrane bioreactors (MBR). Tel Aviv Airport

is a good example of how sewage effluents can be reclaimed in this manner. Given the intensive development of the country, the rising demand for agricultural products and water, as well as the ever-increasing price of land, there is a need to improve water treatment and wastewater reuse technologies, increase their efficiency and shorten treatment time without jeopardising water quality.

Organisation of the Israeli water sector

Israel sees water as a strategic resource and the Israeli water sector is highly developed and managed around national, regional and local management bodies. This has resulted in a generally centralised, highly regulated water management structure with national policy handed down to the regional and city governments for implementation. Consequently, Tel Aviv has a small number of well-defined formal administrative structures responsible for water management. In addition, there are a number of multi-stakeholder platforms whereby developments in water management have long been the topic of discussion. The concept of the SWITCH Learning Alliance (LA) was, although slightly difficult to grasp initially, not wholly new to Israel.

Pre-existing stakeholder groups include the key organisations involved in the water sector in Tel Aviv, managing drinking water supply and distribution, stormwater, wastewater collection and treatment, effluent supply and water re-use. Meetings generally take place quite regularly, from once a month to once a year, depending on the committee function. Members generally know each other very well and have well developed and close working relationships. It was within this context that SWITCH Learning Alliance process was launched and the core team quickly realised that using existing structures was liable to produce better results than introducing a new water platform in the city. This has proved a correct assumption.

Box 2 Key Departments in the water sector in Tel Aviv

The Ministry of Health deals with the control of drinking water quality, water sources and permits for drilling wells for drinking water. It performs environmental studies that show safety radius areas and checks the quality of drinking water, performing bacteriological, chemical and hydrological monitoring.

The Ministry of Interior has a Central District Regional Committee for Urban Planning that is responsible for issuing permits for infrastructure - roads, sewer, natural gas, city-trains, intercity trains, and public area building like schools and parks in the Tel Aviv region. It has a mandate for all planning performed by the Ministry of Interior and is the professional body of the Regional Committee with a strong influence on its decisions. The director of the Committee is the chief administrator of the Region for the Ministry of Interior.

The Ministry of Infrastructure - Water Authority is the main regulatory body for the water supply and demand, responsible for all water resources in the country. It issues permits to

produce water from different sources including desalination and reclaimed water and issues quotas for end-users that restrict the use of a specific type of water to the allocated quota.

Mekorot National Water Company engages in a wide range of activities in the management, operation and treatment of all types of water resources: surface water, underground water, brackish water, seawater and effluents re-use. These include low-cost desalination of seawater and brackish water, water reclamation, advanced water project engineering and development of major infrastructure projects, flow catchment and rain enhancement.

The Tel Aviv Municipality Water, Wastewater and Drainage Department manages the supply of drinking water to the city and the disposal of wastewater. It is responsible for the drainage of stormwater together with the Yarkon River Catchment Authority.

The Dan Region Association of Towns supervises wastewater quality from the industrial plants, the collection and transport of wastewater to the Dan Region WwTP, and treatment of the waste, passing on effluents to Mekorot for further tertiary treatment and re-use in the south.

The Municipal Water Works Administration is part of the Ministry of Interior and is involved in the decisions about planning and budgeting water supply and distribution systems.

Water issues in Tel Aviv

Water shortage and growing water demand

Issues surrounding water in Israel are typical of many countries in arid regions. Presently 66% of the 450MCM of wastewater (300 MCM per year) of treated municipal sewage is reused for irrigation, which is about 30% of the total water supplied to agriculture (about 1000 MCM per year). The increase rate of the population, which is about 1.5% annually, and the corresponding urbanisation of Tel Aviv and its surroundings expected within the next 20-30 years, will undoubtedly deepen this problem. An increase in the demand for housing and a shift in agricultural land demand to the South of Israel is expected, while greater desertification in the southern parts are likely occur due to climate change. Water will have to be derived from alternative sources such as desalination and re-use. Indeed desalination is currently supplying over 400 million cubic metres per annum of potable water, and this will increase to provide about 80% of all potable water in the near future. The use of effluents for municipal and public purposes (street cleaning, fire fighting, irrigation of park and recreational use) and also for food production will need to be increased to conserve drinking water supplies. It is predicted that agricultural water consumption (more than 50% of the total consumption of the country) will reduce although agriculture will continue to remain the key economic activity in the south of the country. Maintaining high

quality effluents from the Dan Region (TA area) will be crucial for its continued development. Wastewater reclamation will become one of the key important strategies for meeting growing future demand.
More local effluent re-use for public irrigation and river replenishment is also expected to play a key role and this may come from small local treatment plants, which could use diversified treatments based on advanced technologies or natural systems (e.g., constructed wetlands). However at the level of the various ministries and water sector bodies, there is a growing concern about health issues regarding the extensive use of treated effluents and the potential for long-term environmental problems, concerning the fate of micropollutants in these re-used water supplies.

Box 3 Wastewater treatment from Greater Tel Aviv

The Greater Tel Aviv (Dan Region) urban area is composed of seven municipalities producing more than 130 Mm3/yr of wastewater from the Tel Aviv Metropolitan area and several other neighbouring municipalities.

The Shafdan WwTP treats the sewage biologically (single-stage simultaneous nitrification - de-nitrification) and delivers the effluents for further tertiary treatment using the classical soil-aquifer treatment (SAT) technology (infiltration of the secondary effluents in open fields). High quality reclaimed water produced by this technology is used for unrestricted irrigation in agriculture in the south of Israel (Negev), and enables its economic development.

Presently 66% of the 450MCM of wastewater (300 MCM per year) of treated municipal sewage from the Dan Region of Towns is reused for irrigation, which is about 30% of the total water supplied to agriculture (about 1000 MCM per year). Of this, more than three quarters is sent as tertiary treated final effluent to the farms in the south/Negev for growing vegetables, etc. and the remaining quarter is disposed of to sea when wet winters reduce demand for final effluent.

Existing infiltration areas are no longer able to expand due to land restrictions due to rapid urbanisation, and increasing hydraulic loads due to demographic increases in the region. There is, therefore, a need for improvement of the re-use technologies, in order to increase their efficiency and shorten the time of treatment without jeopardising the treated and reclaimed water quality.

Box 4 Local recovery system fails to win national approval

Located north of Petah Tikva, and founded in 1949 as a small immigrants' village, Ganei Tikva received its municipal status in 1952. In the 1990's its proximity to the Tel Aviv resulted in a construction boom and the small village tripled in size and population. This has put additional pressure on public services, in particular water and sanitation provision.
The Municipality decided, with the help of Ayala to introduce their own “third pipe” system so that all new buildings are provided with greywater recovery pipelines, which keep greywater separate from the blackwater waste in sewage systems. In the municipal plan,

this greywater is conveyed to horizontal constructed wetlands which clean it up and send it to a number of cascading pools within a park. The treated effluent arrives at a large reception tank at the lower end of the park where it would be screened and pumped to provide irrigation water to the Municipality landscaped areas.

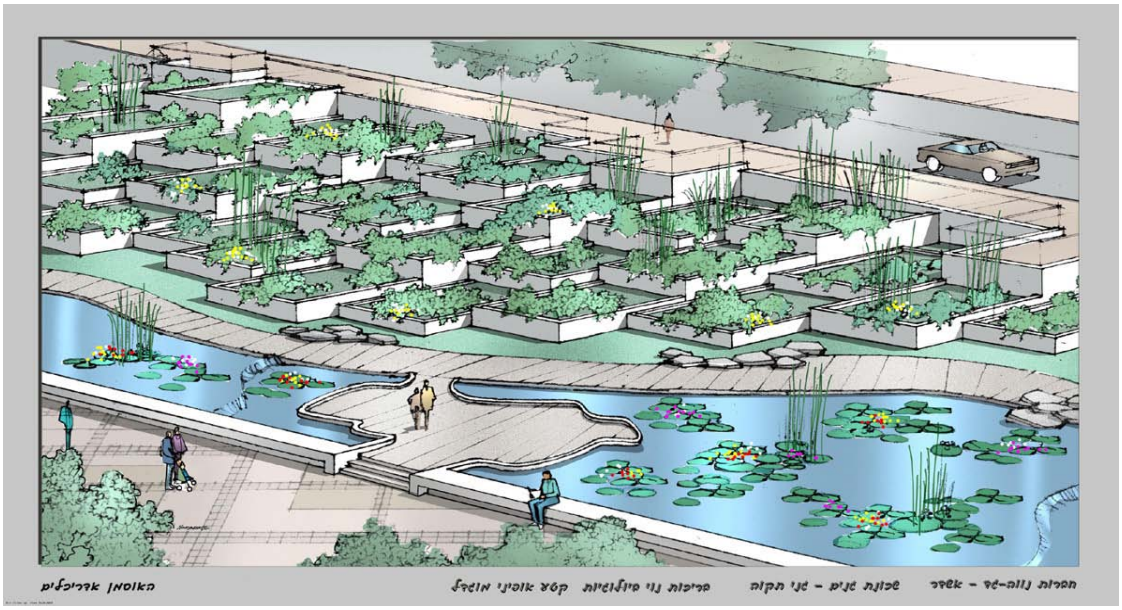

Figure 2 Artists impression of linear park with wetland treatment beds and ponds
Source: Ganei Tikva

Although the system has been constructed, it has yet to be officially commissioned as the Ministry of Health will not give a license, saying that they are concerned about the long-term safety of the system and the potential for contamination of the ponds where children may be exposed to a hazard.

The Tel Aviv Learning Alliance discussed this matter with the Ministry of Health and a Member of Parliament who has taken up this matter. There are discussions as to how this might operate as a demonstration under the supervision of an Israeli institution (such as a university) that would be responsible for monitoring and maintaining a safe environment.

While there are legitimate concerns for the longer term maintenance of such a greywater linear water park the issues surrounding this are quite complex, including the competing ideologies of central versus local/source treatment and re-use.

There is concern that if individual municipalities adopt local greywater capture, flows to the central WwTP (Shafdan) will reduce and so will the amount of final effluent available for delivery to the south of the country. This would have economic effects and also may not be so well controlled (water quality) as is currently the practice using the centralised approach.

Box 5 Yarkon River Authority

The Yarkon River Authority (YRA) was created to rehabilitate this heavily polluted and environmentally degraded river, integrating issues relating to water management, ecology, aesthetics and leisure. The seven main municipalities through which the river flows formed the YRA to prepare a Master Plan to restore the river to its former glory and to combine this with a leisure and ecological Yarkon Park. Tel Aviv is of course the largest of these cities and the key member of the YRA, which is now two thirds of the way through implementing its plan.

The Yarkon was one of the few rivers in Israel that had a permanent flow of springs, fed from the mountain aquifers in the central region. Today, water has to be pumped from the ground to feed the river. Reasonably good quality water feeds agriculture up to a point just east of the city of Tel Aviv. From then on water quality and quantity rapidly decline.

The YRA is involved in most of the planning processes that influence the Yarkon and controls discharges into the river by waste water treatment plants and from construction sites and agriculture, etc. It acts as an advisory body and tries to coordinate activities between the stakeholders to achieve their mandate. The Mayor of Tel Aviv is a supporter and is in direct contact with the General Director, Dr David Pargament.

The Master Plan includes increasing the flow by introducing fresh water at the head of the river and by accepting final (tertiary treated) effluents. Just before the river estuary, water is pumped out and treated by membranes to allow for park and agricultural irrigation. A portion of the flow continues downstream to maintain river continuity. This has the effect of maintaining the estuarine environment and providing a much needed supply of water for irrigation. Ammonia standards have been placed on the wastewater discharges in order to maintain a healthy fish (aquatic) environment and reductions in metals and chemicals have been addressed by discharging final effluents through wetland systems.

Dr Pargament saw an affinity between what YRA was doing and what SWITCH was trying to achieve. He became convinced that the Learning Alliance approach should continue after the end of SWITCH as a vehicle to continue building and maintaining partnerships. The SWITCH IWM Indicators were of importance to YRA, and could be built-into the Master Plan.

Dr Pargament is initiating similar approaches to catchment management across Israel. At regular meetings with the Environmental Protection Agency he has discussed how to better integrate sciences/research with the practical management of watersheds and water resources. One major concern is the small number of trained “hands on” managers and professionals in comprehensive water resource management.

Figure 3 The proposed Wetland in Hod Hasharon
Source:

Figure 4 Yrakon River
Source:

SWITCH in Tel Aviv

The Sustainable Water Management Improves Tomorrow's Cities' Health (SWITCH) project is a major research partnership funded by the EC, with a budget exceeding €20 million, undertaking innovation in the area of integrated urban water management (IUWM). Rather than focusing solely on new research, the project aimed to put research into use across different aspects of the urban water cycle in order to improve integration and scaling-up, and ultimately to achieve more sustainable urban water management.

The inception of SWITCH in Tel Aviv was initially seen to very much follow on from work carried out in a number of previous research projects as shown in Box 6.

Box 6 Projects linked to SWITCH

Mekorot (National Water Company) is the City Coordinator jointly with HUJI (Hebrew University) and one of the major stakeholders in the SWITCH Tel Aviv Learning Alliance.

Mekorot is actively involved in the SWITCH project and uses its vast experience in field implementation and research into effluent reclamation technologies to contribute to the research and demonstration elements. It also contributes to the Learning Alliance by disseminating this experience in water and wastewater management and training stakeholders involved in water re-use. The company has extensive experience since 1998 of participation in EU projects, including:

- 4th EU Research Program with a project entitled: CATCHWATER "Enhancement of Integrated Water Management Strategies with Water Reuse at Catchment Scale" and in the 5th EU Research Program with a project entitled: "Integrated Concepts for Re-use of Upgraded Wastewater - AQUAREC".
- In the 6th EU Research Program, Mekorot was participating in two research projects on the improvement of Soil Aquifer Treatment (SAT) systems by hybrid SAT and membrane processes. One was UF- short-term SAT, with RECLAIM and short-term SAT- NF, with SWITCH.

The EU RECLAIM project flowed naturally into SWITCH in Tel Aviv in terms of further research and application of the technology to eliminate micropollutants. The SWITCH research was set to show the complementary nature of both projects.

SWITCH in Tel Aviv took a number of opportunities to intervene in the Tel Aviv waterscape.

Soil aquifer treatment demonstration (SAT + NF)

The researchers asked SWITCH to look at what happens to micropollutants in the final effluent being transported through the Third Line for irrigation of crops, many of which form the all-important export market. Primarily this gave an opportunity to look at how the SAT treatment and recovery system can be monitored and improved in order to demonstrate the removal rates of micropollutants in the re-used effluents coming from the Shafdan WwTP. To this effect, the Tel Aviv Short Term SAT - Nanofiltration (NF) Demonstration was implemented. There are however limitations in the ability of the current system in Shafdan to meet demand:

- Increasing population results in more sewage awaiting treatment.
- Gradual clogging of dune areas results in a decrease in infiltration capacity.
- Low temperatures cause high viscosity and low evaporation rate.
- The SAT plant occasionally overflows during winter rain events, as the combined sewerage systems collect about 10% of stormwater from the city.

During such events, part of the treated sewage from the wastewater treatment plant is pumped directly into the sea, wasting the potential SAT-recovered water and impacting on the environment. It has been estimated, that about 2-3% of the treated sewage (3 MCM/annum) goes into the sea without being re-used. Other reasons why SAT is limited are space availability and limitations in small communities.

Space availability

Soil Aquifer Treatment (SAT) requires a relatively large space for gradual infiltration, which takes some 6-12 months depending on the season. The average infiltration velocity of the conventional SAT is 0.5-2 m/day (hydraulic loading - 60-230 m/annum; 1 day flooding and 2 days drying). To process 400,000 m3/d of the Shafdan effluents, 1,100 ha of land is used for infiltration. There is a lack of land for infiltration especially as more space is needed on rainy days in the winter. Meeting the requirements for increasing amount of sewage while using traditional technology, requires extension of the land area for recharge to the aquifer that is used for reclaimed water only. Dynamic growth in the Tel Aviv metropolis, escalating land prices and pressure from developers is leading to a lack of space, limiting the potential of current traditional forms of SAT.

Limitations of existing SAT technologies

Although the SAT technology has been operating for several decades, there is a need to eliminate technical problems which slow up filtration (e.g. clogging) and upgrade the chemical parameters of the reclaimed water.

Wastewater reclamation options for small communities

Other technologies are also needed in alternative wastewater reclamation systems for smaller communities, in areas that lack the access to a "qualified" aquifer or have too limited space to use SAT. Such alternative technologies include constructed wetlands (CW), electroflocculation (EF), CW-EF hybrids and granular filtration (GF), which are investigated in SWITCH in collaboration with the HUJI team.

OBJECTIVE OF THIS PAPER

The central objective of this paper is to review the progress and development made by the SWITCH partners in Tel Aviv since 2006, but especially since the 2008 City Assessment. This paper, therefore, aims to look at the characteristics of the process of the Learning Alliance development and the key impacts made and examine some of the options that were still available to the Tel Aviv team in the last year of the SWITCH project. It attempts to capture the progress made and support moves towards further implementation in the City of Tel Aviv. The paper is based upon the experience of the members of the SWITCH Team in Tel Aviv - the City Coordinators and the Learning Alliance Facilitator, and also on the experience and opinions of members of the Tel Aviv Learning Alliance captured during semi-formal interviews conducted in April 2010, and upon the review of the project documents and materials produced within the progress in the application of SWITCH in Tel Aviv.

This paper outlines key elements of the SWITCH project intervention methodology in Tel Aviv, including the project's theory of change (intervention strategy) and the approach to development of the Learning Alliance, highlights results achieved to date and suggests, by way of lessons learned, recommendations intended to help both SWITCH in Tel Aviv and other cities to maximise impact and sustainability.

Methodology

SWITCH set itself the difficult task of bringing about a "paradigm" shift in the way that water is managed in the cities of the future. In order even to partly achieve this ambition, the consortium needed to challenge not only the way things were done but also attitudes and approaches to water management in a changing world.

As well as carrying out a review of the impact and progress made by the Tel Aviv SWITCH team, this paper also makes comparisons with observations in the 2008 assessment (Wagner, Dziegielewska-Geitz et al., 2008) and identifies potential activities that could be achieved to maximise on those achievements.

As Learning Alliances have been widely seen as a central pillar of the SWITCH ideology for implementing change in their Cities, much of the report has been given over to the comments, opinions and suggestions provided by Learning Alliance members at semi-formal, face to face interviews. A review of the composition of the group was carried out using a gender/discipline matrix and the results in Gender Analysis of Tel Aviv Learning Alliance shed light on gender balances in the field of water management.

In order to obtain a better insight into how the impacts that SWITCH has been making and how this learning has been developed and used in Tel Aviv a review of the available process documentation was also been carried out at the same time.
It must however be recognised that during relatively short visit that much of the report relies upon anecdotal evidence and a relatively small amount of written information. It therefore does not pretend to provide an in depth examination of the status or overall impact of SWITCH in Tel Aviv.

II. THE SWITCH INTERVENTION LOGIC

Based upon the Tel Aviv "theory of change" the SWITCH Project has adopted an intervention logic which aims to make a difference in the future water management and water related aspects of the city and meets the growing water demands of the landscaped areas in the city and the agricultural lands beyond the urban areas The intervention working hypotheses is based upon:

Field monitoring and laboratory experiments provide a scientific basis for new treatment processes

Many of the research institutions involved in SWITCH have long-term expertise in soil aquifer treatment (SAT), electro flocculation (EF) technologies and constructed wetlands (CWs), which constitute some of the key issues addressed by SWITCH. Research on these topics has been based upon that in other programmes, most specifically in RECLAIM, which was looking for alternative technologies for water reclamation for unrestricted irrigation. The research particularly concentrated on:

- Ultra filtration (UF) of the secondary effluents and dug well injection at short term (up to two months) SAT
- Comparison with the actual long -term (up to 12 months SAT) systems.

The overall aim of the SWITCH research was to combine CW and electroflocculation (EF) technology to upgrade secondary treated effluent to the level that would permit its safe use for stream rehabilitation, park irrigation and other municipal uses that require very high quality reclaimed wastewater. It also looked at the removal of micropollutants in these reclaimed water resources in order to better understand the capability of the processes involved. One of the major issues was to investigate the efficiency of phosphorus removal by conventional CW and combined CW-EF systems, considering the mitigation of the typical effect of the seasonal excess of the phosphorus release over its retention within a constructed wetland. The research concentrated on evaluation and comparison of the efficiencies of a constructed wetland and the electrochemical technology when used both in parallel and series.

Research into CWs was conducted in the Water Treatment Technology Laboratory of the Hebrew University, under the leadership of Prof. Avner Adin. SWITCH in Tel Aviv put considerable effort and resources into laboratory and field experiments and monitoring systems (hydrological parameters of the aquifer and wetlands, analysis of chemical and physical parameters of water) in order to quantify fundamental processes related to CW and hybrid treatment methods.
They obtained good data that provides a baseline for the successful design and monitoring of such treatment processes.

Testing new technologies at pilot scale to validate the technology and provide a basis for scaling-up by the WwTP

Based upon the results of some of the research coming from the earlier RECLAIM project it was important for SWITCH to check and compare, in a field demonstration pilot, an alternative method based on the principle of removal of the “clogging” material by an extensive short SAT and final polishing on a nano-filter which efficiently removes the micropollutants. Two types were tested NF 270 and NF 90. This was adopted as the SWITCH Demonstration activity in Tel Aviv.

Preliminary planning for a pilot plant in the Shafdan WwTP started in the second half of 2006. The biggest problem encountered was in assigning a suitable site from a hydrological aspect. This required an extensive hydrological study up to mid-2007 when a suitable site was eventually selected. The construction of the SAT+NF pilot started and the first 3 SAT fields were constructed, each one being 5x8 metres with an observation well 5 m. from the SAT fields and a recovery well 15 m. from the SAT fields.

Research and demonstration

SAT is not a new process in Israel and has been the chosen method of tertiary treatment and recovery of treated final effluents (Shafdan WwTP) for several years. However as Israel looks to grow fruit and vegetables for export to high value markets in Europe and other regions they need to be constantly vigilant to the risks of contamination through the re-use of these final effluents as irrigation water. Hence the interest in the demonstration for refining SAT by the inclusion of nanofiltration, looking at what happens to micropollutants.

Short-term SAT+NF

In the SWITCH pilot experiment using nanofiltration (NF) as a polishing stage it was shown to be capable of removing more effectively certain fractions such as sulfamethoxazole and also obtained a very low dissolved organic carbon (DOC) level when compared with results obtained using UF-RO membrane processes. This result was obtained with no significant clogging of the NF due to the short SAT pre bio-filtration.

When the NF 90 (a more permeable membrane) was used, more energy (working pressure 6 bar instead of 3 bar) was found to be needed and less water was recovered (70% instead of 90%) although this enabled swift no-clogging operation of the membrane and salts to be almost completely removed. But as the NF-270 was also effective in removing most of the targeted micropollutants its use will lead to a more economical solution even if almost complete salt removal is not actually necessary.

The importance of removal of micropollutants in drinking water and reclaimed unrestricted irrigation water is increasing as new detection methods become available. Of major concern are the fate of endocrine disruptors, antibiotics and pharmaceutical micropollutants.

Electroflocculation - constructed wetland hybrid for improved phosphate removal in effluent re-use

Work on constructed wetlands acting in combination with other “hybrid” processes (treatment trains) was also considered to see if this would improve reduction of phosphates in effluents destined for reuse.

- Complementing CW treatment with a physicochemical process of electroflocculation can provide a tertiary treatment that effectively polishes secondary municipal effluent. While EF effectively reduces phosphate in both soluble and particulate forms, CW treatment provides an effective transport-attachment trap for turbidity that escapes the electro-physicochemical process and removes organic matter and other nutrients.

- Laboratory tests showed that electroflocculation coupled with sand filtration effectively removes phosphate and suspended particles in contrary to the wetland gravel performance. The wetland gravel effectively removed organic matter, possibly by microbial degradation.
- Field pilot results showed that the EF rector is capable of removing up to 97% of the total phosphorus, getting final concentrations smaller than 0.4 mg/l. Former electro-jar tests followed by continuous-flow, bench-scale results showed similar capabilities of up to 96% removal. The system is optimised for phosphorous removal by controlling current intensity, which represents coagulant dose and by controlling flow rate, which controls reactor residence time and turbulence.
- The hybrid process also enhances the removal of suspended solids (87%) and organics (53%) in addition to phosphorus removal. A well designed sand filtration following the EF reactor is therefore a key output and highly recommended.

The Tel Aviv Learning Alliance – the Water Club

The initiating organisations in the SWITCH Consortium in Tel Aviv were the Hebrew University of Jerusalem (HUJI) and Mekorot, the State Water Company. Both organisations have a long history in initiating international research projects of this nature.

A central pillar of the SWITCH concept was a decision to adopt the Learning Alliance approach in each of its demonstration cities in order to better integrate the science with the needs of the practitioners in water management in those cities. Because of the strategic importance of water to the State of Israel the country has, over the past 60 years, developed very sophisticated structures through which water is regulated and controlled. It was seen to be important that the Tel Aviv Learning Alliance was not seen as an attempt to create another institution. The concept of a Learning Alliance type stakeholder platform was seen to be successfully adopted in the form of what is locally referred to as the “Water Club”.

This went on to develop strong internal communications and has identified some real issues in water management that may not otherwise have been directly addressed, in particular the lack of discrete sustainable water indicators within the Tel Aviv City Master Plan, something that was recognised during the Tel Aviv Visioning Workshop.

The Municipality of Tel Aviv is preparing a Master Plan for the city, and it is thought that this will become a flagship example of urban planning which will be taken up by other municipalities in Israel. The plan is based on wide public participation; consensus building; early completion and formulation of action plans which are

widely recognised to be transparent and published. The plan includes a series of over 50 indicators, which form the basis of a monitoring system for the implementation of the plan and show the progress by indicating the changes in Tel Aviv, as well as comparing these results with other cities in the county and even abroad. The Learning Alliance prepared water indicators for the plan – see Learning Alliance outputs.

Formation and development of the Learning Alliance

The Tel Aviv Learning Alliance was established at a Scoping Meeting held from 30 July - 3 August 2006, and explained above became known as the SWITCH Water Club. It was important that SWITCH was not seen to be usurping the role of any of the official water institutions but was performing the role of an open meeting place for many of these institutions.

The member organisations of the Water Club, including those that joined later, are:

- The Central District Regional Council for Urban Planning of the Ministry of Interior.
- The Water, Wastewater and Drainage Department of the City of Tel Aviv.
- The Dan Region Association of Towns.
- The Water Authority of the Ministry of Infrastructure.
- The Ministry of the Environment.
- The Ministry of Agriculture.
- The Environmental Health Department of the Ministry of Health.
- "Man, Nature, Law" - an NGO.
- The South of Israel Farmers' Association.
- The Water Workers' Association.
- MEKOROT - the National Water Company.
- Soil and Water Department at the Hebrew University of Jerusalem.
- The Israel Water Association.
- AYALA Water & Ecology.
- Yarkon River Authority.
- Haham – Ben Zvi Architects/Elram Consultants.

The organisations were represented by individuals who contribute to the decision-making process in the national, regional and municipal water sectors. The members of the Water Club have the ability to develop a vision and also the ability to promote it into the city development programme. These important characteristics of the members are, in the view of the Tel Aviv Learning Alliance facilitator and coordinator (Avital Dror-Ehre and Avi Aharoni), crucial to establishing and disseminating the idea of the Learning Alliance as a key process for sustainable development in Tel Aviv and other cities in Israel. The members of the Water Club generally hold senior positions in essential water institutions in the Tel Aviv region

and thereby gave the Water Club a degree of authority. The Learning Alliance concept of working in such a group has shown to them the benefits of the method and it is expected that this sort of platform will continue in the longer term. Mekorot, the National Water Company is one of the key members and the majority of Water Club members have already assimilated the SWITCH ideas and recognised the potential benefits that can be derived from such association and from working closely with other institutions as part of the learning alliance platform. Many of them confirmed their opinion that the Water Club provided a "safe" space in which they could voice their opinions and openly discuss cross-sector issues.

SWITCH is an excellent platform: *"What SWITCH is doing is really good as you are awakening the awareness that there are other approaches to water management. SWITCH should be about changing people's minds as they have a really strong voice and who else is there better to say these things."*
Interview with Eli Cohen, AYALA Water & Ecology

Learning Alliance objectives

The objectives of the Tel Aviv Learning Alliance, both in the long and short term, were defined by Mekorot, HUJI and UNESCO-IHE during the Scoping Meeting, from 30 July - 3 August 2006. These were refined or adapted in the various Learning Alliance meetings that followed.

The long-term objectives describe what the Water Club wanted to achieve in terms of policy for change and implementation within the perspective of the 5 years + time frame.

- Relevant research results and dissemination of the entire SWITCH project (i.e. not only those achieved by the research conducted in Tel Aviv). This appears to have been achieved in relation to the work/demonstrations that have been carried out in Tel Aviv. Members of the TA LA have been very active in attending international conferences and symposiums both in Israel and abroad which have promoted the SWITCH concepts.
- Adoption of the SWITCH approach to urban water management. This appears to have been adopted by the stakeholders in TA where the strategic planning water indicators are a good example. There was anecdotal evidence that the Water Club platform would continue after the SWITCH programme, probably as a council of experts and stakeholders who can be consulted by water sector institutions. There is evidence to suggest that the Water Club will continue to show leadership in integrated urban water management.

In the latter stages of the SWITCH programme a number of follow-up projects were identified and future funding opportunities started to be examined. For example, the Ministry of Health asked SWITCH members to scope a research project to look

in closer detail at what happens to micropollutants in recycled wastewater when it is used for agriculture irrigation.

The involvement of the Water Club in some of the projects described in this paper provides a basis for perpetuating the learning alliance type platform well beyond the existence of SWITCH.

Box 7 Learning Alliance assisted architects plan for "Green House" water capture building

Haham-Ben Zvi Architects were given the opportunity to develop an environmentally sustainable building in Tel Aviv. They selected a site within the University grounds, and were inspired by an impressive "Four Roomed House" dating from the Middle Eastern Iron Age Period at the Nabataea settlement site close to the Yarkon River. Haham-Ben Zvi tried to replicate in 21st century terms many of the features of this ancient building. This project has the possibility of becoming something of a "water museum" providing students and other visitors with modern interpretations of ancient water management systems.

One feature was maximising the capture of scarce water and this was planned to be by recycling, rain-harvesting, air-conditioning condensate capture as well as energy conservation using solar energy together with the use of the natural capacity of the site for ventilation purposes. The "Green House" ecological building was planned for a sloping site in the University grounds. The architects met with members of the SWITCH Tel Aviv Management Team and asked them to help them develop the concept of this building and promote this idea to serve as a focal point for more sustainable buildings in Israel. It is thought that this building may indeed help to prove and promote the safe recycling of greywater in Israel almost serving as a demonstration of this practice on a small scale.

Shalom Goldberger, Chief Engineer for the Ministry of Heath, Tel Aviv, says they find it very difficult to give licences for local greywater recycling schemes, as it is often very unclear how these plants will perform and how they will be maintained over time. There is a lack of information on smaller scale systems and therefore a real risk of exposing the public to effluents.

However, he said that the Green House would be a useful demonstration of this small scale greywater recovery and reuse in a controlled environment. He expected to learn a lot from this when it is constructed.

After discussions at Water Club meetings, the Ministry said it would be prepared to look at the Green House as a well-controlled and managed demonstration of small scale greywater recycling on a university site, which would assist them in developing guidelines for the future.

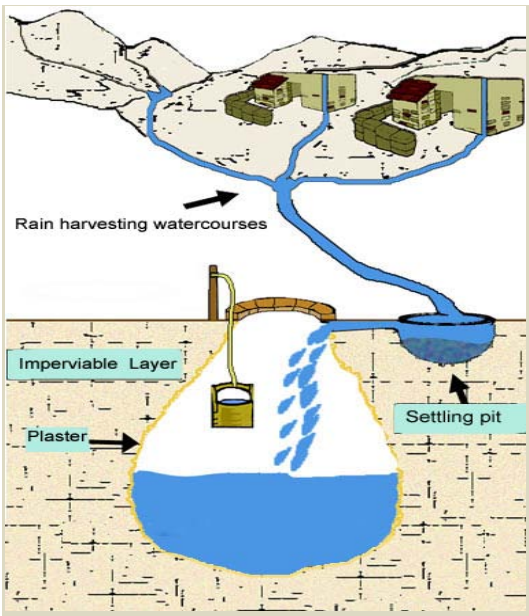

Figure 5 Iron Age water collecting system

Source:

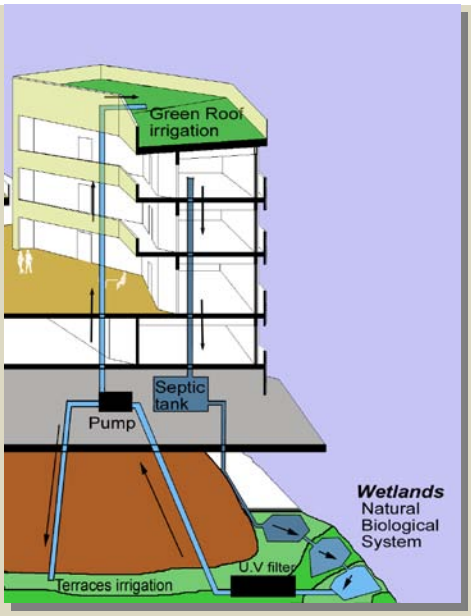

Figure 6 Green House water collecting system

Source:

Short term objectives included:

- In Water Club meetings, stakeholders were familiarised with the planned research (UF+Short term SAT, Short term SAT+NF demonstration, CW and EF+CW). All of these (see Appendix C for explanations of acronyms) were looked at in the project to support expanded use of final effluents for irrigation. Although these research projects were largely already proposed and approved by the EU prior to the Water Club being formed, this work was supported and adjusted based on the feedback from those attending Water Club meetings and all the Learning Alliance members apparently supported these proposals.
- The discussions within the Learning Alliance evolved into three possible future scenarios for urban water management in Tel Aviv. These scenarios were the subject of further analysis by researchers and the development of sustainable water indicators came as a direct result.
  Good working relationships were established with the two institutions in Tel Aviv working on the development of sustainability indicators (The Water Commission and the Strategic Planning Unit in the City Engineer's Office). SWITCH became very involved in the development of a set of indicators covering issues such as sustainability and risk, for incorporation into the future City Master Plan. This received the approval of the City Mayor's Office, which is probably unprecedented in terms of water management in Israel.

These objectives were regularly revisited and re-adjusted throughout the project, including the meetings/events below.

"SWITCH has created the possibility of a better understanding that an integrated approach to water management is the way forward and to this extent SWITCH must be seen to have been successful. In the longer term it remains to be seen what the real impact of SWITCH in Israel will have been but generally it will have been a good experience…
"Man has linked himself to rivers and he must adopt proper practices to facilitate the amenities that the population deserves. …After all, the Water Cycle is one and we have artificially divided it."
Interview with David Pargament, Yarkon River Authority

Activities, facilitation, and documentation
Completed SWITCH Learning Alliance meetings include:

- Scoping Meeting on 30 July-3 August 2006.
- The Sustainability Indicators for Planning and Decision Making for Integrated Urban Water Management – Meeting, 10-11 November 2006.
- SWITCH Consortium Scientific Meeting, November 2007.
- Water and irrigation conference, June 2008.
- Updated planning meeting, March 2009.
- SWITCH International Symposium on City Water Indicators for the Strategic Planning of Tel Aviv, held in Tel Aviv, 13-14 January 2010.

The main documentation regarding the development and progress of the Tel Aviv Learning Alliance includes:

- Scoping Meeting Report (2006).
- Project Sheet Tel Aviv (2006).
- Presentations delivered at the November 2006 meeting (on the global SWITCH website).
- Tel Aviv Stakeholder Network (2006).
- Website - Urban Strategy - Tel Aviv (2006).
- Draft Report on Theme 1 workshop: "Sustainability indicators for planning and decision making for IUWM" (2007).
- Learning Alliance Report (2007).
- City Storyline 2008, Tel Aviv, Israel (2008).
- Tel Aviv City Storyline. (2009).

Assessment/indicators
The SWITCH monitoring and evaluation approach was not fully adopted by the Tel Aviv team. (The Learning Alliance Facilitator was not able take part in the Ghana workshop in December 2007 which agreed this and was not familiar with the process.) Nevertheless, a Monitoring and Evaluation exercise during the 2008 City Assessment Review was included in the report (Wagner, Dziegielewska-Geitz et al.,

2008). A further M&E exercise was carried out in the 2010 assessment. The results of which are reproduced below:

Box 8 Indicators for Tel Aviv Learning Alliance

Objective 1: We know who Learning Alliance members are, and facilitate communication between them effectively.
Benchmark: There is an up-to-date record of all Learning Alliance members and their involvement, and some basic communication tools are systematically used (e.g. email, phone) between events and regular involvement in external events and seminars, etc.
Score: 60%

Objective 2: Regular, effective and innovative events capture and sustain interest of Learning Alliance members.
Benchmark: Appropriate events are announced well in advance and use a mix of mainly standard methods to effectively engage interest of city stakeholders at least once every 3 months.
Score: 45%: Regular events are indeed held but at least every six months and these are having an impact in capturing the interest of the learning alliance members. There is a need for more frequent meetings.
Score: 45%: Events that are well attended by most of the learning alliance are held at least twice a year. The events are announced well in advance and prepared well. Learning Alliance members were well aware of these and were interested attendees. Meetings are not so well documented although a number of papers have been published. Some of these publications are available on the intranet site.

Objective 3: Demonstration activities are undertaken within a framework for scaling-up.
Benchmark: Demonstration activity plans are consistent and integrated within Learning Alliance plans (city storylines) and are supported and there is good anecdotal evidence of a commitment to scaling-up.
Score: 65%: Demonstration activity plans are consistent and integrated within Learning Alliance plans and city storylines. SAT and Wetland technologies were established in the SHAFDAN WwTP (pilot scale). Entrepreneurs with potential to scale up demonstration of wetland and green roofs are active members of the Learning Alliance group.

Objective 4: The SWITCH team and Learning Alliance understand why change is occurring in IUWM, not just what happening.
Benchmark: A few process documentation tools are used regularly and results are widely shared within the Learning Alliance.
Score 35% (Learning Alliance team): Some minutes of Learning Alliance meetings are available. A series of articles is used to share information about learning alliance and SWITCH with the water community. A systematic documentation process or tools are not really seen to be useful in the context of the Tel Aviv Learning Alliance. Note: The LA Facilitator has not participated in most of the learning alliance facilitator workshops, training and meeting such as M&E and documentation. The City Web Site has not been completed.

This 2010 assessment showed a small improvement over 2008, largely as a result of the strong and consistent attendance by key members of the Water Club and the SWITCH team. What did not really improve in the intervening period was project administration in terms of process documentation, the City Web Site, Learning Alliance reports, etc. Despite similar comments in the 2008 City Assessment Report, actions to support or encourage more consistent monitoring and evaluation were not instigated to rectify this situation.

This was recognised as a weakness by the City Coordinator and Facilitator but has been put down for the most part to budget/resource constraints. Nevertheless it is considered that the additional effort involved in developing a City Web Site and providing updated Learning Alliance reports would have been a good investment which would have given strong support to the Water Club members and other SWITCH Cities, particularly in view of some of the unique features of the Tel Aviv approach. It is clear, however, that some positive results, such as an active learning alliance membership and some very relevant research, were achieved despite missing documentation.

III. RESULTS AND DISCUSSION

Research results and findings

Improvement of the technology for the soil aquifer treatment (short-term SAT+NF)
The research was conducted in a Dan Region Shafdan WwTP facility. The RECLAIM and SWITCH projects strongly contributed to micropollutants analysis of the secondary effluents and long term SAT water used today for irrigation in Israel. The presence of micropollutants in water is one of the main discussion topics within the Water Club and with major stakeholders (governmental offices, academic institutions and Mekorot). This demonstration together with similar projects inside and outside SWITCH have contributed to the development of hybrid SAT-membrane processes that can produce very high quality water out of secondary effluents and can be used as alternative processes to UF-RO processes that consume more energy and are more expensive. It has also been shown that micropollutants can effectively be removed by the short SAT+NF 270 process thereby obtaining safe quality water for reuse in agriculture.

The Ministry of Health is committed to following up this research programme to look in more detail at the fate of these micropollutants to see how they are taken up in the vegetables and crops grown and to make assessment of the risks, if any. To this extent, it can be said that SWITCH has made an impact on water management in Israel.

Coupling other processes with constructed wetlands (CWs)

Laboratory experiments evaluating the efficiency of removal of selected nutrients by CW and its combination with other techniques (GF, EF) have a major advantage. They provide data that should be very useful in the current debate on centralised versus localised effluent/greywater recycling. The research was highly relevant and the results encouraging enough to say that it has taken the issue of recovering and reusing wastewater and greywater a step further and that this is a welcomed development. Constructed wetlands are starting to be seen as safe solutions that can be integrated into "treatment trains" to produce consistent results.

Demonstrations

The short-term SAT+NF and the constructed wetlands demonstrations provided much needed information for refining the advanced final effluent recovery processes being used in Israel and so contribute to greater water efficiency and the safer use of final effluents in unrestricted irrigation. They have given an opportunity to various members of the learning alliance, and others through training and dissemination workshops, to see scaled up working models that enable them to have a better understanding of these processes and the part they can play in water reuse. The publication of this data will support other organisations and countries who are piloting the development of similar systems in water stressed environments.

The demonstration of constructed wetlands with electroflocculation is seen to be of great benefit in assisting various ministries and planning offices to permit greater use of localised effluent re-use in appropriate circumstances so that this can be incorporated into future developments. Similarly the short-term SAT+NF provide confidence that less expensive treatment methods are available, using less land to increase the efficiency of the existing centralised final effluent re-use for agricultural.

Learning Alliance outputs

Water indicators in the City Master Plan

The Tel Aviv Learning Alliance provided a much needed forum for cross-sector discussion between stakeholders and for enhancing learning through workshops and seminars held during the SWITCH programme. One initiative with the greatest potential for visible and sustainable impact on urban water management in Tel Aviv relates to the Learning Alliance inspired concept of introducing sustainable "water indicators" into the urban planning process. This has the potential to link the water issues indelibly to the emerging Master Plan for the city, recognising the role of the

water sector in spatial development, strategic planning and delivery of the Tel Aviv City Vision.

Although the draft city plan contained more than 50 indicators, none touched on water. The proposal was for the Learning Alliance to establish a Steering Committee supported by a water expert to develop preliminary indicators to be submitted to the Municipality of Tel Aviv for inclusion in the Master Plan, along with those for education, health, transport, housing, etc. These would cover unaccounted for water, water demand, sewer separation, roof water collection, impervious area preservation and other issues. The Mayor of Tel Aviv gave his blessing to the development of water indicators – which is a real endorsement – and a motivator for the Learning Alliance since it ensured that there was a mandate for this to be addressed in the City Plan. As an essential part of the debate surrounding the water indicators the water expert and committee was to look at measurements whereby these indicators could be monitored. Once agreed by the Municipality they would become final indicators and the results from monitoring would be given to the public at regular intervals.

SWITCH puts a vision for water into the Urban Master Plan for Tel Aviv.
"SWITCH through the Learning Alliance (Water Club) has alerted Planners to the need to build-in the water vision into the City Master Plan in its development stage rather than to fit the water systems around the plan at a later date.
We know now, thanks to the SWITCH approach, that to ignore the integrated water management approach in our Master Plan would be missing out an essential aspect of urban planning and we are really looking forward to getting the work on water indicator started as soon as possible now. If SWITCH is to make a lasting impact in Tel Aviv and Israel as a whole then this work is a vital deliverable for the Learning Alliance".
Interview with Guido Segal, Planner, Tel Aviv Municipality

Learning Alliance processes

Avital Dror-Ehre, the SWITCH City Facilitator reported on a number of specific Learning Alliance processes in the overall context of a successful, if unorthodox approach to building a functioning Learning Alliance (Water Club) in Tel Aviv:

- **Tel Aviv institutional mapping:** This was not done as a separate exercise but formed part of the City Story Stakeholder/LA Member Identification Process.
- **Tel Aviv – institutional analysis**: This was not done as there was a general feeling that Institutions, particularly in the water and other related sectors are very well defined and known.
- **SWITCH City Stories:** They completed a SWITCH City Story in late 2008/early 2009; a comprehensive document that lists in detail the activities achieved and further activities planned. It is not clear how closely this was monitored in

terms of the actual achievements obtained. It does however map the various institutions within the water landscape in Israel.

- **SWITCH strategic planning in Tel Aviv**: Plans updated in March 2009 show that there was a review related to the delivery of the water indicators for the Tel Aviv Master Plan. It describes the activities required and nominates the Steering Committee responsible for delivering these activities.
- **Visioning workshop:** Done essentially as part of the Learning Alliance meetings relating to the City Strategic Plan and Master Plan development work.
- **Process documentation:** There is little direct evidence of process documentation although there are a number of papers published; posters have been produced at various SWITCH seminars and also locally for symposiums and seminars. This indicates that a high level of documentation was produced.
- **City web site:** This was never fully realised.
- **Monitoring & evaluation:** M&E processes were carried out infrequently and were not really used as a tool to guide the Learning Alliance process. Nevertheless, three M&E exercises showed an upward trend which is indicative of becoming more comfortable with the Learning Alliance process and seeing members taking part in activities on a regular basis.
- **Water Club meeting reports:** Not done in any recognisable format but Tel Aviv had a member on the SWITCH Management Team who was reporting back regularly and there was a good attendance at the core SWITCH scientific meetings and similar gathering that keep SWITCH informed on progress in the city.

IV. CONCLUSIONS, COMMENTS, RECOMMENDATIONS AND LESSONS LEARNED

- The SWITCH Management Team in Tel Aviv have been able to show that through the implementation of the Learning Alliance methodology and the impact of scaled up physical demonstrations, and by sharing research ,the various stakeholder organisations and municipal departments are better able to share information and understanding. The process of developing the Water Club made the various water professionals, urban planners, scientists, agriculturalists and environmentalists feel more comfortable in speaking to each other on matters relating to water management in all its aspects and to move further towards bringing about changes that will lead to integration in the management of water in their city.
- This process was greatly facilitated by the strong reputations that the key SWITCH Tel Aviv Management Team have in both the agricultural and water sectors in Israel and they have been able to bring this to benefit the SWITCH Project.

- It is recognised that water management in Israel is of strategic importance and it is generally accepted that Israel is one of the leading countries in the world with regards to water treatment, water efficiency, irrigation systems and water re-use. However it was only through the intervention of SWITCH that sustainable water indicators have been incorporated in the new Tel Aviv Strategic Plan.
- SWITCH introduced the concept of the Learning Alliance approach to bring about integration in the water sector in each of the SWITCH Cities and from both anecdotal evidence and from the outputs of the programme itself it is clear that the Learning Alliance concept has been enthusiastically adopted in Tel Aviv, albeit with some interesting local reinterpretation.
- There was an understanding that each country in the SWITCH consortium has its own and culture and would have its own approach to the Learning Alliance methodology to fit its particular set of circumstances. In this respect, perhaps a greater focus on the process of selecting and training local individuals would have provided a faster start and a better understanding of this way of developing an effective stakeholder group. There was clearly a lack of understanding of the role the reporting and process documentation play in the approach.
- The Water Club was very much seen by its members as an informal platform which, even without the benefits of more systemised process documentation and reporting, went on to achieve some very positive outcomes such as advancing SAT processes and initiating sustainable water indicators in the next version of city strategic plan.
- Monitoring and evaluation of progress in Learning Alliance development was made using the agreed four objectives common to all SWITCH cities. The 2010 evaluation showed a small but significant improvement over 2008. It is generally accepted by the Tel Aviv SWITCH team that certain administration matters, such as reporting, process documentation, stakeholder analysis, etc. have not been high enough on their agenda due to pressure on time and resources and that this resulted in certain targets being missed.
- It is widely considered that including sustainable water indicators in the developing Tel Aviv Yafo Strategic Plan has the potential for very significant and long lasting impact in the city. The fact that all Learning Alliance members appear to be agreed on this particular intervention in the Master Plan will, if delivered, have a lasting impact for SWITCH in Tel Aviv and potentially Israel as a whole. It is likely that other cities in Israel will follow this lead when planning their own urban environments.
- Most of the water sector stakeholders in Tel Aviv operate at national level. The interviews conducted (list of interviewees) show that most of them are well aware of the objectives of SWITCH in Tel Aviv although this understanding did take some time to evolve. The Water Club has been recognised as a platform

where the majority of water sector participants can meet and exchange ideas more easily than in “official” meetings.

- The Learning Alliance facilitator is perceived by her team colleagues as a respected and dedicated professional, who is comfortable with the concept of a multi-stakeholder platform. She possesses extensive knowledge of the Tel Aviv/Israeli water sector, water issues and problems; she knows the stakeholders, their perceptions and expectations. However, she was heavily committed to her work outside SWITCH and may not have been provided with sufficient resources to undertake this role in the manner envisaged. It was initially decided by the Tel Aviv team that the facilitating the SWITCH Learning Alliance would be a half-day a week job. It was later recognised that a full-time resource commitment was required to complete all the activities expected, such as organising and facilitating Learning Alliance meetings, reporting, communicating with the Learning Alliance and the management team and fully participating in training events.
- The initial concept of having a Global SWITCH Learning Alliance was thought by those interviewed to have been a good concept and the failure to establish this was seen, therefore, as a missed opportunity. Shared research and experiences were also areas where it was considered SWITCH could have provided more impact. A number of interviewees said that they had greatly benefited from the global meetings/symposiums they were able to attend through SWITCH.
- The City Coordinator felt that SWITCH suffered from large amounts of bureaucracy and administration and that this may be seen as a missed opportunity to streamline the approach and free up time for other activities. This to some extent also tended to inhibit publishing research findings.
- The Water Club was composed of strong and committed individuals from various water institutions in Tel Aviv. However, the membership may have been too close to the day to day management of water and water related issues. Despite the early inclusion of an NGO and a farmers’ association in the Learning Alliance it was difficult to maintain their longer-term interest and regular attendance. The reasons for this are not well understood and perhaps there is a need to better explore this phenomenon in more detail across the SWITCH Cities to see if this was a common experience, examine the dynamics and try to ensure that wider stakeholder participation can be achieved in future programmes.
- Although the demonstration projects were largely defined prior to the formation of the Learning Alliance (due mostly to the EU bidding procedures), they were generally endorsed by the Learning Alliance membership as being very useful in the context of improving knowledge of safe wastewater reuse. There was widespread agreement on the need to undertake further scientific work on the SAT process and the potential for reductions in land use and the occurrence of micropollutants in treated wastewater effluents.

Importance of including municipal water engineers
"To some extent Municipal Water Engineers see themselves as reactive to the Urban Planning Process rather than a part of it and it is very important they are included at the very early stages of the planning process".
Interview with Guido Segal, Planner, Tel Aviv Municipality

Recommendations

- There was a very high level of expectation within the Learning Alliance and the City of Tel Aviv that SWITCH would actively support the development of sustainable water indicators for the Water Chapter in the City Master Plan. This was seen to be a vital element for SWITCH in Tel Aviv with the potential to have a lasting impact on the city.

- The Green House presented a relatively easily achieved impact in the city. A letter of support was sent from SWITCH (UNESCO-IHE) to assist in seeking further support for the development of this sustainable building.

- Demonstration of short-term SAT+NF has shown this to be a low cost and relatively easy to replicate option for treating waste water effluents to a high quality for use in unrestricted irrigation of cops on a large scale. Further papers, training and dissemination relating to this demonstration will ensure the continuation of the uptake of this piece of research.

- Support for research on constructed wetlands was very cogent in the current debate regarding local versus centralised wastewater recycling and the research has added to the available body of knowledge on various treatment options.

- LIST OF INTERVIEWEES

Interviews with Learning Alliance members

Water Club members and members of the management team were interviewed during an assessment visit to Tel Aviv in 2010. The authors would like to thank them for their participation and for their insights into the processes. Much of what they told the team has been used in the main body of this report, and is not therefore repeated here.

Dr Avi Aharoni, Head of Wastewater Treatment and Effluent Reuse, Mekorot and Dr Haim Cikurel, Consultant
Avi Aharoni and Haim Cikurel were involved from the inception of SWITCH in Israel and were also key players in the earlier successful RECLAIM project. They were unfamiliar initially with the Learning Alliance process but reached a stage whereby they felt that SWITCH without the Learning Alliance component would not have so successful or active, as this gave them a much wider vision of water issues and allowed many different organisations to become involved.

One illustration was the involvement of SWITCH in the Green House project which has enabled the Learning Alliance to support the proposals of a group to build an environmentally sustainable building in the grounds of the Tel Aviv University (see Box 7).

Both Avi Aharoni and Haim Cikurel took part in international events through SWITCH and have presented papers at the Scientific and Water Summit Meetings. In addition they have hosted a large international attendance at similar events in Israel and also to visiting students based at IHE and other SWITCH consortium partners.

Eli Cohen, Proprietor of AYALA Water & Ecology Moshav Zipori, Israel
Founded in 1989, AYALA is a private company. Its broad interest starts in water ecology, aquatic plants and continues into the field of phytotechnologies such as constructed wetlands which they refer to as NBS – natural biological systems. Eli Cohen explained about his company's efforts to introduce constructed wetland and other phytotechnologies into Israel (and other countries). One of his current projects is the Ganei Tikva (see Box 4).
Eli Cohen is looking to promote low technology, localised or source recycling of grey/wastewater and he has a demonstration plant treating landfill leachates at the former Hiria Landfill - an 80-meter high mound, which is very visible from the Jerusalem-Tel Aviv highway. Currently Hiria Landfill is being transformed into the Ariel Sharon National Park (alternatively known as the Ayalon Park).

Figure 7 Grey water
Source: Ganei Tikva

Figure 8 Visitors Centre and Wetland
Source: Hiria Landfill

He was introduced to SWITCH in Tel Aviv when asked to present at a Symposium in connection with the Green House. He also presented papers in the Cost 859 Group of Scientific Workshops on phytoremediation of wastewater. He has been involved in the Yarkon River Restoration Project (Yarkon River Authority) by promoting the integration of constructed wetlands in the seven-station area is being implemented.

Dr David Pargament, General Director of the Yarkon River Authority (YRA)
David Pargament did not hear much about SWITCH in Tel Aviv until he was asked to present at the SWITCH 2010 Water Symposium in Tel Aviv in January 2010.

He is a supporter of an integrated approach to water resource and watershed management and considers multi-stakeholder involvement as a major strength in the Water Club, as he sees integration of water management, ecology, aesthetics and leisure as "life enhancing qualities" of YRA work.
Dr Pargament wanted SWITCH to give direction/suggestions to funding work after SWITCH had ceased as a project. Otherwise, he feared that everyone would "go back to their former entrenched positions".

Professor Avner Adin, the SWITCH City Coordinator, Water Treatment Technology Laboratory, Hebrew University, researcher
Professor Avner Adin was the SWITCH Coordinator in Tel Aviv from the commencement of the SWITCH programme. He was actively involved in the establishment of the Learning Alliance, the demonstrations and the research and feels that for SWITCH in Tel Aviv to really show the "power" of their achievements, more time is needed as this is all about creating a future possibility. To him the essence of SWITCH is that integration of different technologies and approaches rather than merely looking at one technology versus another. It is the power of combining hard and soft forms of technologies than can really show the benefits.

The concept of managing a very large scale research project was quite daunting for most participants. The Learning Alliance approach was new and time was needed to enable SWITCH participants to gain insight into how this approach could be used and best arranged. They adopted this concept and shaped it to something works in the Israeli context, and this has been very successful.

They lacked the budget/time availability for their facilitator to attend the Learning Alliance Training Sessions and this meant that they never really caught-up with the process side of the programme. However they have nevertheless ended up with a large, diverse and essentially active Learning Alliance. SWITCH derived some momentum from the RECLAIM project but the best catalyst for the TA Learning Alliance was the dialogue surrounding the development of water management indicators for the Tel Aviv Master Plan.

Demand-led research was not necessarily a new concept. There is a tradition in Israel of mobilising researchers in the water industry and constantly seeking new ways of managing water supply and irrigation. Nevertheless, SWITCH contributed to this tradition, especially when it was discovered that there was no water chapter in the Strategic Plan for Tel Aviv and this omission was addressed.

The researchers have become more experienced in dealing with government and private practice counterparts and this will continue to assist them in developing future research.

Mr Guido Segal and Einat Amoyal Tel Aviv Municipality, Planning Department

Urban Planners have to deal with many different subjects and cannot be experts on all aspects of urban systems and infrastructure. The Planning Department of the Tel Aviv municipality consists of 12 staff, including architects, urban planners, geographers and psychologists. They deal with planning at national, regional and city levels to assess how land use within the city will be allocated and rely on other departments and external inputs to provide for complex interactions and integration.

Since 2006 this team has been working on a Strategic Plan for Tel Aviv for 2020, which has been accepted and approved by the Planning Committee and the Mayor of Tel Aviv. Since 2008 they have been compiling a Master Plan based on the Strategic Plan and have presented this to the Planning Committee. The Master Plan also looks at how to build-in sustainability and prioritise issues related to ecology, energy, etc. Individual municipal departments will draw up short to medium term implementation plans based on the Master Plan and these will form the basis of departmental budgets and be monitored for compliance and consistency.

When urban planners attended their first Learning Alliance workshop and realised that the Master Plan did not include a specific chapter on water management, they agreed to work with SWITCH to develop a water chapter.
This led to a series of phased activities to profile the urban water systems, formulate an urban water vision and policies and devise sustainability indicators.

Segal thought that the six monthly intervals between Learning Alliance meetings were about right although they were disappointed that the water indicators appeared to be taking such a long time to put in place despite their engagement.

At the time of the interview, Segal and colleagues were waiting for SWITCH to appoint the Water Expert and for a budget to implement this exercise and were anxious that this should be completed without delay. They saw the opportunity for SWITCH in its final twelve months in Tel Aviv to create a major and lasting achievement with the indicators, and one that would be taken up by other Municipalities across Israel.

The Infrastructure and Construction Administration Department is a statutory body that has the power to refuse planning applications in Tel Aviv. Its leading officers are strong supporters of the Strategic Plan and Master Plan.

The director, Dr Benjamin Maor was very receptive to SWITCH ideas, especially the water indicators, and was instrumental in putting these to the City Mayor. He went to great lengths to emphasise how important these indicators were to the SWITCH intervention in Tel Aviv going so far as to say these were “urgently needed now”. He said that delivering on their indicator proposals would give the Water Club a mandate to continue in some changed form in the future. They could even become the Monitoring Group for sustainable water indicators.

The other aspect that interested him related to the recycling of greywater. Israel has been recycling sewage effluents for some time but local greywater collection and treatment for localised irrigation of municipal green areas is new and there is a real need to develop the necessary guidelines/regulations to develop and control this.

Dor and Rami Ben–Zvi, Haham-Ben Zvi Architects/Elram Consultants, Kiriat Tivan, Israel, with Professor Ben Zion Borovsky, Electrical Engineering Department, Tel Aviv University

Haham-Ben Zvi Architects were given the opportunity to develop an environmentally sustainable building in Tel Aviv (see Box 7). They found the SWITCH Tel Aviv Learning Alliance a good platform where they could solicit support for their project, learn about sustainable water management and facilitate stakeholder dialogue.

Shalom Goldberger, Chief Engineer, Ministry of Health

Shalom Goldberger is the Chief Engineer for the Ministry of Heath Tel Aviv and has two Regional Engineers to help cover the conurbation. He was involved in the Tel Aviv Learning Alliance from near the beginning, attended several meetings, and met members of the SWITCH international team. He sees the research that SWITCH was doing on whether there are risks from micropollutants as very important, as recycled wastewater is used on a very large scale for irrigating fruit and vegetables. There is therefore a concern to know if there are any tangible risks from this process.

Figure 9 **Alternative reuse models - centralised and de-centralised for re-use scenarios**

Source:

In his opinion it would not be true to say that things happened only through SWITCH but he acknowledged that SWITCH had played a part in promoting an integrated water management approach in Israel. He very much liked the research plus learning approach.

Regulation in the field of reuse of tertiary treated final effluents, such as in the case of Shafdan WwTP, was reasonably well developed but he was looking at new quality issues and the implementation of new processes such as UF and NF, and this made him interested in the SWITCH demonstrations on SAT.

He saw that SWITCH was able to bring an international dimension to water management and felt that one of the major outputs from SWITCH was to provide learning from other cities around the world.

He would have liked more international meetings for people to learn and share experiences.

Shalom suggested that SWITCH could make recommendations as to how the Water Club could continue after the project was completed, as a really useful platform that did not otherwise exist in Israel.

Miki Zaide, Planning Department, Water Authority
Miki Zaide leads the work that the water authority is doing at National Level Master Plan and was very interested in the water indicators being developed in Tel Aviv under the SWITCH initiative. He would particularly like to see the thought processes that other countries are going through to identify their water indicators and would welcome more opportunities to collaborate.

He initially felt that the SWITCH Learning Alliance concept was "slightly vague" but after a while started to see real benefits from shared learning experiences and the power of hearing about case studies from other cities. He recommended continuation of the project by sharing study cases in each country and city.

David Jackman, CEO Mei Aviv – Services, Tel Aviv - Yafo Water Company
David Jackman was a key member of the Tel Aviv Learning Alliance from the start. Initially he saw a problem in being able to define the expected outcomes of research. However the SWITCH Water Club/Learning Alliance included people from many different parts of the Israeli water sector and when they met people from other countries, such as Holland, Poland and Brazil, they did start to understand what was trying to be done in their city and they welcomed this. He was invited to present at SWITCH summit meetings in Delft. He was particularly impressed with the presentation by the city of Rotterdam.

Initially, he was sceptical of the concept of putting water indicators into the Tel Aviv Master Plan but after seeing how the Municipality, right up to the Mayor's office had embraced these, he became convinced that this would be a very productive intervention.

The Learning Alliance was a difficult concept at first and consisted mainly of the statutory bodies. He felt that greater efforts could have been made to explore the concerns and ideas of the NGOs and farmers' association and to engage them more fully with the process as they attended at the beginning but did not continue as they did not find it useful. He pointed out however that Strategic Planning process did involve extensive engagement with a very wide range of groups.

David Jackman had also been sceptical about changing the way that water was managed in Tel Aviv, but as he experienced the Water Club accepting change and keen to explore new ideas, the relationship between his department and the City

Planners benefitted from the SWITCH Learning Alliance and they felt much more comfortable in exchanging ideas and information.

He was pleased to see the growing relationship between the “twinned cities” of Tel Aviv and Lodz. He found the connections with other SWITCH cities exciting and encouraging and felt that if there had been more international collaboration, SWITCH would have been able to deliver more by way of change in Tel Aviv, and more by way of training.

A lot of the SWITCH ideas are about how urban networks are managed and he would have been very interested in what new approaches were being adopted in other SWITCH Cities.

Avital Dror-Ehre, SWITCH City Facilitator Tel Aviv Learning Alliance

Avital Dror-Ehre explained that organisations in the Tel Aviv Water Club were represented by individuals who contribute to the decision-making process in the national, regional and municipal water sectors. The members of the Club generally hold senior positions in essential water institutions in the Tel Aviv region and this has been really significant in the progress that the Learning Alliance has achieved.

Avital Dror-Ehre recognised that they had been less able to undertake the “administrative activities of SWITCH” as her time was been limited by the budget to less than half a day per week, and she was not able to attend many of the SWITCH training sessions. She was however quite comfortable that the Tel Aviv Learning Alliance had been established, and that members defined themselves as being “members of the SWITCH Water Club”. By using their own “intuitive approach” attracted high level players, achieved a high level of attendance at meetings and achieved good outcomes despite their unorthodox approach.

Gender Analysis of Tel Aviv Learning Alliance

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Female

Acronyms

CW	Constructed Wetlands
CW-EF	Constructed Wetlands and Electroflocculation Hybrids
DOC	Dissolved organic Carbon
EF	Electroflocculation
EF-GF	Electroflocculation and Granular Filtration
GF	Granular Filtration
HUJI	Hebrew University of Jerusalem
IUWM	Integrated Urban Water Management
LA	Learning Alliance
MBR	Membrane Bioreactor
M&E	Monitoring and Evaluation
MCM	Million Cubic Metres
NBS	Natural Biological System
NF	Nanofiltration
RO	Reverse Osmosis
SAT	Soil-Aquifer Treatment
SAT+NF	Soil-Aquifer Treatment With Nanofiltration
SWRO	Seawater Reverse Osmosis
TA LA	Tel Aviv Learning Alliance
UF	Ultra Filtration
UF-RO	Ultra filtration and Reverse Osmosis
WwTP	Wastewater Treatment Plant
YRA|	Yarkon River Authority