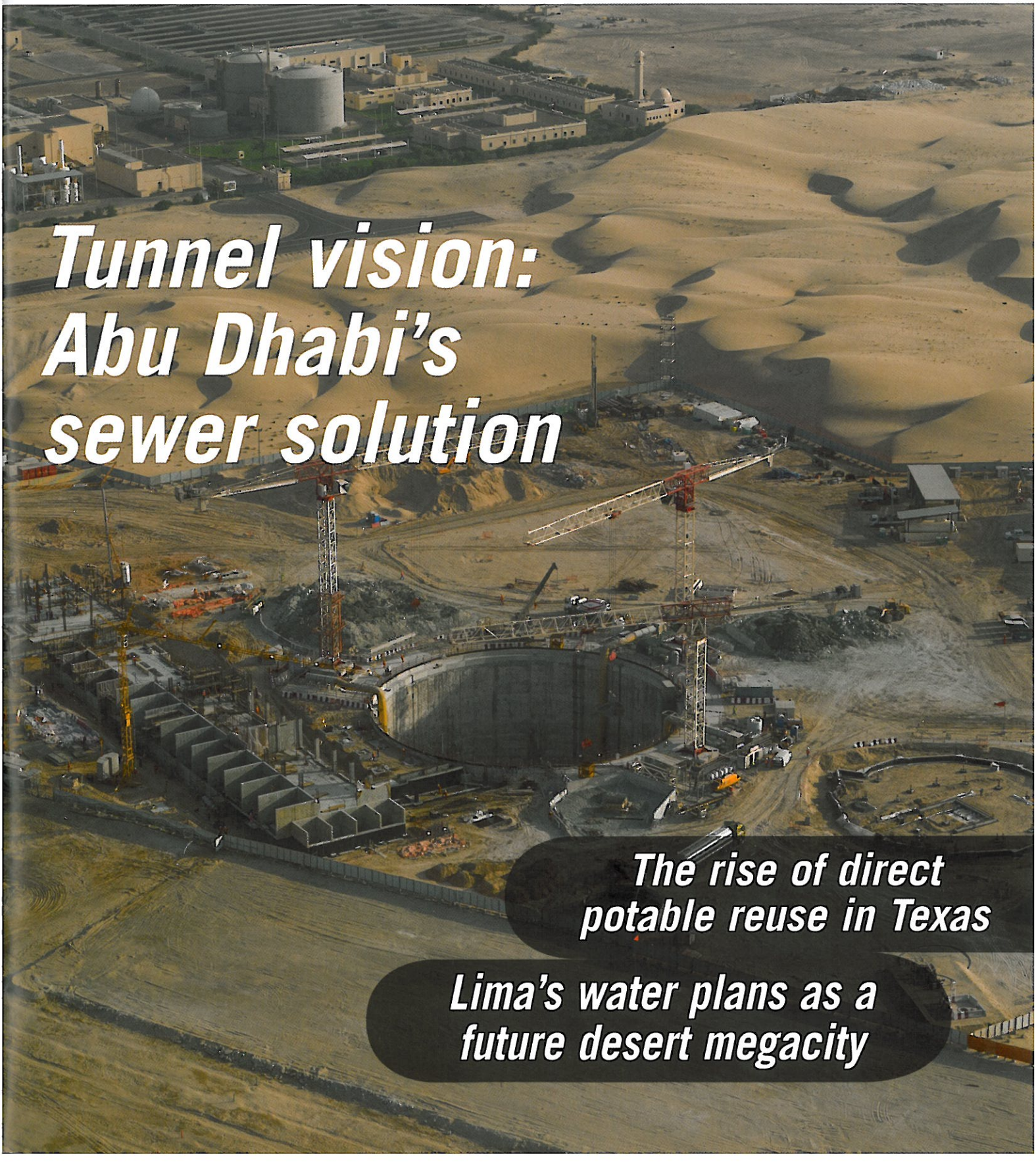
water21

August 2014

Magazine of the | International Water Association



Tunnel vision: Abu Dhabi's sewer solution

The rise of direct potable reuse in Texas

Lima's water plans as a future desert megacity

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caspianmedia.com

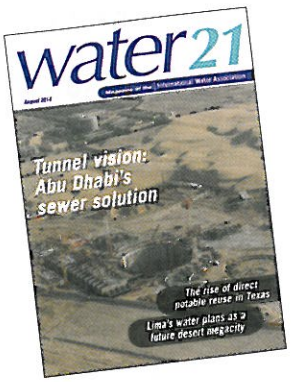
Water21 is published six times a year by IWA Publishing (address as above). Statements made do not necessarily represent the views of IWA or its Governing Board.
Water21 is received by all members of IWA (see IWA website for fees). Institutional (library) subscription rate (2014) is £347/US$637/€553 (including online access), from:

Portland Customer Services,
Commerce Way, Colchester,
CO2 8HP, UK
T: +44 (0)1206 799351
E: sales@portland-services.com

Design & layout:
IPL Print & Design Ltd
Print: Warners Midlands plc

ISSN 1561-9508

Why the name 'Water21'? 'The general objective is to make certain that adequate supplies of water of good quality are maintained for the entire population of this planet, while preserving the hydrological, biological and chemical functions of ecosystems, adapting human activities within the capacity of nature and combating vectors of water-related diseases. Innovative technologies, including the improvement of indigenous technologies, are needed to fully utilize limited water resources and to safeguard those resources against pollution.' From 'Agenda21', the UN programme of action from the Rio Earth Summit, 1992.



COVER STORY

Abu Dhabi's Strategic Tunnel Enhancement Programme is one of the world's largest wastewater infrastructure improvement projects, with 41km of deep tunnel and 45km of link sewers being constructed to transfer flows for treatment. Lis Stedman explores this vast undertaking, which is being seen as a key move to underpin Abu Dhabi's economic development.

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Surface view of the shaft which will house a 1.7M.m³ per day peak capacity pumping station to transfer wastewater from the new sewer to the Al Wathba sewage treatment plant. Credit: ADSSC.

REGULARS

IN THIS ISSUE...

The population of Peru's capital, Lima, is predicted to soon pass ten million people. However, with the city being one of the driest in the world and water scarcity already an issue, providing water services to this fast-growing city is a pressing concern. Keith Hayward looks at a water action plan with a time horizon to 2040 that aims to ensure a secure future for the city's supplies.

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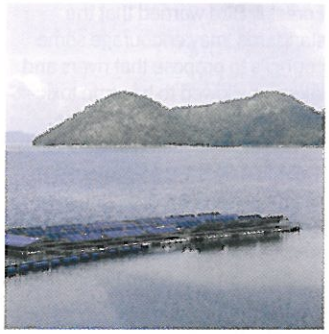
FEATURES

GLOBAL FOCUS



REUSE

IWA WORLD WATER CONGRESS & EXHIBITION PREVIEW

NETWORKS

Construction of Abu Dhabi's huge new sewer system

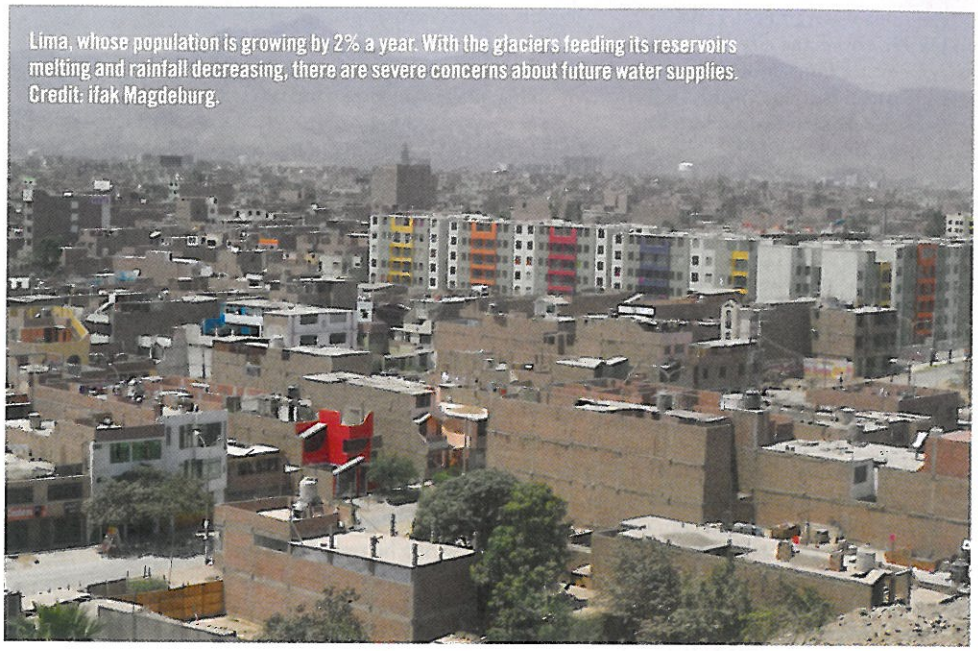
SOUTH AMERICA

MONITORING

How research into illicit drug use is opening up new opportunities to track and monitor disease.

Lima 2040: water management for a future desert megacity

● Lima, the capital of Peru, is already struggling to provide water services to its inhabitants yet faces a future of dwindling supplies and a population due to reach the megacity ten million threshold in the coming years. **KEITH HAYWARD** spoke to **MANFRED SCHÜTZE** about the Lima water project and action plan for 2040, which aims to secure Lima's future water supplies.



Lima, whose population is growing by 2% a year. With the glaciers feeding its reservoirs melting and rainfall decreasing, there are severe concerns about future water supplies. Credit: ifak Magdeburg.

With rainfall of just 9mm a year, the Peruvian capital Lima is one of the driest cities in the world, alongside Cairo in Egypt. Clearly this means the water available locally is not enough to sustain a population of more than nine million people – a figure rising by around 2% a year. So the city draws its water from reservoirs up in the Andean mountains.

'Since the amount of rainfall and glacial melt in the mountains on the Pacific side is already not sufficient, they also built reservoir lakes on the Amazonian side of the mountains, and by trans-Andean tunnels they lead the water towards Lima,' explains Manfred Schütze, coordinator of a project through which German support has been given to Lima's water resources planning.

Even with such efforts, Schütze notes that, while water supply to the richest parts of the city is fine, around 1.5 million of the city's inhabitants are not connected to the water supply system, and that many city districts have a limited water supply, some for only a couple of hours a day. The situation is 'already quite tricky', he says. Furthermore, that is just for the present day. 'One of the concerns [is that] glaciers have melted already in the Andean mountains quite drastically and we expect them to melt even more. And, the amount of rainfall is expected to decrease in the decades to come. So, less water supply coming from the mountains plus increasing population: both factors together give quite severe concerns about water in Lima in the future.'

Given these concerns, Lima was selected to be part of the Future Megacities programme funded by the German Ministry of Education

Trans-Andean tunnel taking water to Lima. Credit: ifak Magdeburg.

and Research, explains Schütze. Other projects have covered solid waste management in Addis Ababa, energy in Johannesburg and sustainable construction in Tehran, for example. 'At present there are nine projects worldwide, the Lima project being the only one in Latin America and the only one focusing on water and wastewater,' says Schütze.

The Lima water project, LiWa, which also covers the city of Callao, part of Greater Lima, brought together seven German partners, mainly universities and research institutes, with four main and four additional Peruvian partners. Coordination of the project has been provided by Schütze's organisation, ifak Magdeburg, and the Peruvian partners have included SEDAPAL, the local water company.

The main phase of the LiWa project got underway in 2008 and the final work has been taking place this year. The aim of the project has been, says Schütze, 'not only to develop methods and tools… but also to put these tools into practice and to do something really useful in practice, in order not to do some ivory tower research.' The main result as far as the city is concerned is that it now has an action plan framed around a vision for 2040. Alongside this, the tools developed during the project are now being made available for use in other locations around the world.

Tools for sustainable water management

One of the most important aspects of the project has been the use of scenarios to support development of the long-term vision. This approach allows the wide range of factors and issues, such as poverty, water demand, climate change and demographics that will shape the water sector to be considered together. Preparation of the scenarios was supported by work by the partners looking at, for example, climate change, for which global and regional models were downscaled to evaluate the prospects for Lima's water sources. Workshops with the Peruvian partners looked at how the various factors might develop in future and then consistent combinations of these developments were brought together within a small number of scenarios (see box).

This use of workshops is indicative of the participatory approach used in the project. In particular, roundtable workshops with a wide range of stakeholders were used to discuss and refine the scenarios as well as to subsequently evaluate the detailed options to be incorporated into the action plan. Importantly, it is not just that the project brought together a wide range of stakeholders, but it provided a neutral platform for them to come together. 'I was quite pleased that after one of the roundtable events, a high official of the water company came to me saying he really liked the discussions at this roundtable and its conclusions, and for the same event a representative of a quite radical NGO came to me saying that she liked that event [and] she found their interests to be taken into account,' says Schütze. 'That gave us reassurance that apparently we managed to take on board all the different points of view.'

Specific tools developed during the project have included, in particular, a water system simulator. This simulates the entire water and wastewater system of Lima in a single model, so that different options can be evaluated under a range of conditions, covering aspects such as water availability, pollution, energy, and revenue (see box). Other tools have included one for assessing the impacts across the entire system of changing water tariffs, while the strong capacity building component of LiWa included an e-learning platform as well as courses and summer schools held in the country.

Schütze points out that the research focus of the project, illustrated by the German project partners and funding agency, means the tools developed during the project are the result of somewhat intensive work. 'In this project, within the research environment we could afford to work in detail on aspects such as climate change, water tariffs and so on, which within a pure consultancy project usually you wouldn't have the time or the resources for,' he says. 'So we, let us say, had the luxury of having been able to do in-depth work on all these different parts of the project and to engage also with the Peruvian institutions more than probably could be done in many average consultancy projects.'

An action plan for Lima

The key output from the project as far as the city is concerned is the action plan (see box). This represents the combined result of the scenarios, the evaluation of these scenarios with the support of simulation, and the additional in-depth work. It has been signed by the key stakeholders, including the water company SEDAPAL, the regulator SUNASS, the National Water Authority, the

Four scenarios for the water and wastewater system in Lima

The descriptors (driving forces) considered:

Government
Water company
Water tariffs
Demography
Urban poverty
Water demand
Water losses
Water catchment management
Urban development
Water deficit
Wastewater treatment and reuse
Water infrastructure
Climate change

The four scenarios:

Scenario A: Climate stress meets governance disaster
Scenario B: The tragedy of isolated measures
Scenario C: The opportunities of mesoscale actors
Scenario D: Climate resilience by governance

Full details can be found at **www.lima-water.de/en/pp2.html**

Although richer parts of the city have supplies, around 1.5 million inhabitants in poorer areas are not connected to the water supply system. Credit: ifak Magdeburg.

Simulating the water and wastewater system

The simulation tool developed for the LiWa project represents the entire drinking water and wastewater system in one single model by using building blocks for each of its main elements (e.g. water purification and wastewater treatment plants, groundwater wells, water networks, tanker trucks, city districts, etc.). City districts are characterised by, for example, population size, distribution of social levels, water consumption patterns and percentage of population connected to the drinking water supply and sewer networks. Besides water quantity, water and wastewater quality and energy fluxes are also considered. This 'macromodelling' approach was chosen to retain a holistic view of the entire metropolitan water system.

The modelling approach is based on the principles of resource flux modelling, with flows and fluxes represented by a system of algebraic, difference and differential equations within the simulator.

The simulator has been designed in such a way that the user and the model developer can easily add and extend the modelling system. For the output of the water and resource fluxes, Sankey diagrams provided a useful means of visualising the fluxes in the water system. Import and export features using Excel as an interface facilitate the application of the programme.

In addition, model setup has been done in different levels of spatial resolution, ranging from an overall city-perspective to more detailed modelling of individual city districts.

Metropolitan Municipality of Lima as well as the NGO and research sector.

'Obviously there are many documents signed in the world expressing good intentions, but what makes our action plan different is that in setting up this action plan all the institutions have been involved by having participated in often quite painful and lengthy but constructive discussions, assessing the scenarios and assessing the various action options,' explains Schütze. 'All of them have been involved for quite a long time, so they knew how the action plan was derived, and how it came into being. It was not a document prepared by somebody in the night and the next day everybody had to sign it.'

The action plan was first signed in April of last year, but Schütze says that it has had further endorsement since. 'In April 2014 we held again some project conferences with more than 100 participants and with representatives of high level persons of the various institutions,' he explains. 'They again expressed the importance of the action plan and their interest to implement it. They didn't keep silent about it. They didn't forget it. So that gives us I would say a justified expectation that they also will implement it in the future.'

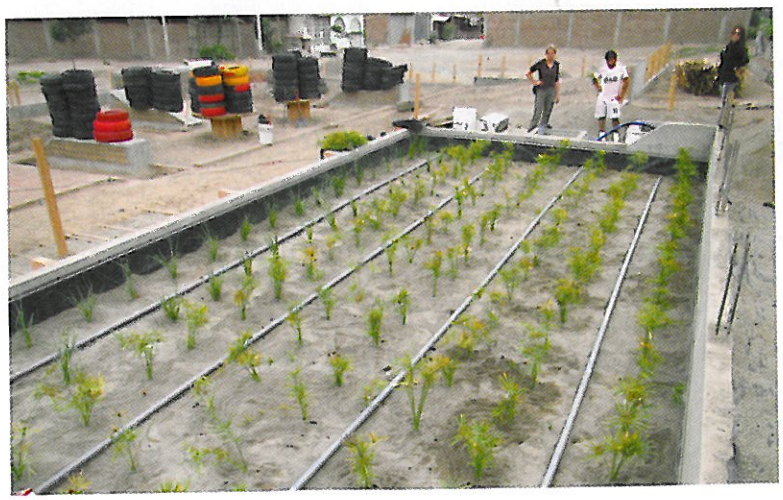
Having said this, it is important for there to be practical progress and this can be seen in the form of a children's eco-park, which opens in the city's San Martín de Porres district in August. This is designed according some new guidelines prepared under the project, adapting the principles of water-sensitive urban design to arid locations.

The eco-park is important in terms of showing that those working on the project can deal with the practicalities of implementation, and that the local population are keen to become involved. It also helps with the wider promotion of the use of water-sensitive urban design. 'Green in a city is nice everywhere, but green in a desert megacity is even nicer, so we hope also by that to encourage even more to think about these concepts and to implement them wherever possible,' says Schütze.

Tools for wider use

A broader benefit of the project is that the tools developed for use in Lima are now also being made available for use elsewhere around the world. 'Within this project, we could afford to develop the methods and the tools and to apply them for Lima. In an application to another city or another region, these tools would not have to be developed again from scratch – they are already there,' says Schütze. He notes though that the tools might need to be adapted to local conditions, and with this in mind a 'transfer document' has been prepared to support this. This, explains Schütze, is aimed at city mayors and gives advice based on the experiences in Lima on the steps needed to adapt the LiWa approach. 'We learnt a lot – what we would do different next time,' comments Schütze, so he says the aim of the document is 'to give practical advice to the mayor or the city government or to regional council of region X [about] what to consider, which adaptations might be necessary, which sort of stakeholders to be considered to invite into this process, which are the obstacles in the modelling process, how to apply the scenario-building method. We [have tried] to summarise that all in one document.'

Schütze points to three lessons in particular from the LiWa work that should be kept in mind. It is very important to think about who the stakeholders are. There is a need, he says, 'to be quite inclusive on that one, so including the regulating agency, the civil sector, and obviously the water company or ministries and so on.' The second is 'to have a lot of patience and to give time to the process', to help ensure that the stakeholders can identify with the project and become



RIGHT: Representatives of the local community, municipality and Ecopark committee in July. Credit: ILPOE, University of Stuttgart.

LEFT: Ecopark wetland during construction, with planning and construction carried out by AKUT Peru. Credit: Ostfalia University Suderburg.

Action Plan 'Lima 2040' in summary

- Agreements to integrate and coordinate city, water and climate risk management
- Strengthening user representation in the Water Resource Council of the interregional Chillón-Rímac-Lurín watersheds
- Promoting Ecologic Infrastructure as a new integrating instrument for territorial and urban planning
- Massive dissemination and sensitization campaigns to promote water saving
- Incentives for water saving equipment and technology use
- Promoting wastewater treatment and reuse
- Sustainable water and sewerage tariff to contribute to reducing consumption and improving equity
- Reducing water losses in the public network
- Improving farming irrigation efficiency
- Building reservoirs in the high and middle watersheds to store water during rainy seasons
- Protecting the river banks and cleaning the river beds for aquifer recharge
- Promoting water-sensitive urban design (WSUD) on open spaces in the city, thus reducing potable water consumption when irrigating green areas

Full details can be found at: **www.lima-water.de/es/pp8.html**

The project partners

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ZIRIUS, University of Stuttgart
IWS, University of Stuttgart
ILPOE, University of Stuttgart
Helmholtz Centre of Environmental Research UFZ
Ostfalia University of Applied Sciences, Campus Suderburg
Dr. Scholz & Partner, Consultant Engineers
SEDAPAL, Water and wastewater company Lima
National University of Engineering UNI, Lima
Foro Ciudades para la Vida, Lima
FOVIDA, Lima

Associated partners:
National Meteorological and Hydrological Service SENAMHI
Regulating Agency for Water and Sanitation, SUNASS
Metropolitan Municipality of Lima
District Municipality of San Martín de Porres

part of it. And finally, Schütze says it is very important to provide a neutral base. 'I think that was one of the strong points of our project,' he says. 'We were not biased by any particular interests. Us coming from outside, but together with the Peruvian partners developing something jointly in an unbiased way, that helped a lot I think.' ●

Acknowledgement
Article based on information provided by the project coordinators, Manfred Schütze, ifak Magdeburg, manfred.schuetze@ifak.eu, and Christian León, ZIRIUS, University of Stuttgart, christian.leon@zirius.uni-stuttgart.de, who wish to acknowledge the project funding by BMBF.

For more information, visit:

Project webpage: www.lima-water.de

'Future Megacities' Programme of the German Ministry of Education and Research (BMBF): www.future-megacities.org