Enhancement of natural water systems and treatment methods for safe and sustainable water supply in India

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Saph Pani

Saph Pani is an EU funded collaborative research project which started in October 2011 with duration of three years involving a consortium of 20 partners from India, European Union, Switzerland, Sri Lanka and Australia. Its full name is "Enhancement of natural water systems and treatment methods for safe and sustainable water supply in India" and it addresses the water challenges of the 21th century. Saph Pani builds on already existing Indian projects for natural treatment and storage of water identifying potential for their improvement by applying high-tech measurement equipment and conducting field trials. For more information, visit: www.saphpani.eu

Special Feature WP4

The Work Package 4 of Saph Pani is called "Post-treatment of water from natural treatment systems for different applications". The objective of WP4 is to analyse the effectiveness of conventional and advanced pre- and post-treatment options for different natural treatment systems aiming at water and wastewater treatment and reuse.

Interview with Saroj Sharma

Saroj Sharma is currently Associate Professor of Water Supply Engineering at the UNESCO-IHE Institute for Water Education, Delft, the Netherlands. He is specialized in water supply engineering - water quality, treatment and distribution. He has 26 years of professional and academic experience in planning, design, implementation, and operation and maintenance of urban, semi-urban and rural water supply projects. His teaching and research interests are in the field of physicochemical treatment processes, natural treatment systems (bank filtration, artificial recharge and soil aquifer treatment) and decentralized water supply systems for small towns and urban poor areas. With his vast experience Sharma has been assigned to be the leader of WP4.

What is the difference between conventional and advanced post-treatment options and how can they help to enhance the water quality from natural treatment systems?

Natural treatment systems (NTSs) like bank filtration (BF) and artificial recharge and recovery (ARR) have been used as methods of water treatment in many countries. Furthermore, constructed wetlands (CWs) and pond systems are very effective natural wastewater treatment technologies. The treated water from these NTSs may not always meet the water quality requirements for intended use or re-use and hence some post-treatment would be required. When the raw water quality is relatively good and site conditions are favourable, one could apply simple conventional treatment methods like coagulation, sedimentation, filtration and disinfection as post-treatment. Many water supply systems in Europe in the past employed BF followed by minimal conventional post-treatment. With the increasing pollution of water sources and due to the presence of emerging contaminants in rivers, lakes and wastewater treatment plant effluents, advanced treatment methods like ozonation and advanced oxidation, activated carbon filtration, ion-

exchange and membrane filtrations are now being used as post-treatment of NTSs. In the present context, NTSs could also serve as pre-treatment for subsequent advanced treatment methods and minimise the overall cost of water and wastewater treatment and reuse.

How can pre-treatment help in the context of natural water treatment?

In general, pre-treatment systems enhance the performance of the NTSs and increase the overall contaminant removal efficiencies. Pre-treatment like sedimentation and sand filtration are commonly applied before artificial recharge and soil aquifer treatment to reduce the suspended solids concentrations in infiltrating water in order to reduce clogging and increase the run time. Screens and primary sedimentation are commonly applied as pre-treatment before CWs and pond systems to minimise suspended solid loading on these NTSs. Sometimes conventional or even advanced pre-treatment may be required before NTSs from the environmental considerations to eliminate the pollutants that may contaminate or affect the soil/aquifer or plants systems employed for NTSs. By employing a proper pre-treatment for NTSs, post-treatment requirements could be minimised, and sometimes even not required.

How is your experience with the project so far?

The Saph Pani project provided the opportunity to explore the current state of application and future potential of NTSs for water and wastewater treatment in India. Study so far revealed that in most of the systems using BF in India, chlorination is the only post-treatment applied. Pre-treatments of ARR systems in India are limited to sedimentation and sand filtration before infiltration which are often incorporated as a part of infiltration structures. There are no municipal water supply systems in India which systematically employ integrated managed aquifer recharge approach (pre-treatment followed by ARR and then post-treatment) for water supply provision. Also with respect to natural wastewater treatment processes like CWs and ponds, post-treatment is nearly absent and limited to chlorination only a few treatment plants. Because of increasing pollution of water bodies in India and due to incomplete or no-treatment of wastewater before disposal (to land or water bodies) in many cities and towns, post-treatment of water abstracted from BF or ARR wells as well as effluents of natural wastewater treatment systems will need greater attention in future in order to meet local drinking water quality guidelines and environmental regulations.

Ammonium and nitrate removal during bank filtration and subsequent post-treatment

(MSc study at UNESCO-IHE: by Haziz Mutabuzi - Tanzania)

The concentrations of ammonium and nitrate are increasing in many surface waters worldwide due to discharge of untreated or partialy treated wastewaters, industrial effluents and agricultural runoffs. Ammonium and nitrates are removed fully or partially in some bank filtration (BF) systems while others show no removal at all or even increased concentrations of these compounds in bank filtrate. Some BF sites in India also show relatively high concentrations of ammonium (Delhi) and nitrate (Delhi/Srinagar). The objective of the study was to assess the potential of BF for removal of ammonium and nitrate under different water qualities and process conditions and analyze subsequent post-treatment options. Laboratory-scale batch and soil column studies were conducted at UNESCO-IHE using different types of model water (prepared from river water, canal water and primary effluent) and silica sand as filter media to analyze the effect of organic matter on the removal of ammonium and nitrate during BF. The research exhibited that BF can considerably reduce nitrogen species from source water (depending up on the concentration and type of background organic matter present and redox conditions) and bank filtrate may require some additional post-treatment for polishing ammonium and nitrate concentrations to meet local water quality standards.

Potential post-treatment methods for ammonium removal are breakpoint chlorination, rapid sand filtration, dry filtration or ion-exchange. Furthermore, ion-exchange, reverse osmosis, denitrification (chemical or biological) can be employed for nitrate removal. The selection of the post-treatment method for the given BF site is guided by

capital and O&M cost considerations and water quality standards.

Role of Female Researchers in Saph-Pani

There are about 30 % women working in Saph Pani at different levels, be it coordination, work package leadership, data generation; modelling etc.

In the course of the project, so far three meetings have been organized specifically for the female researchers in the different work packages of the project. The goal of these meetings was not only to establish a good network between the female researchers in the different levels within the project, but also to discuss issues that might arise for female researchers working in the field of hydrogeology and water science in India and in Europe. A further idea was to enable young female scientists to identify and exchange experience with female role models, i.e. experienced researchers in relevant positions in science and education.

The first meeting was more formal, starting with an introduction among the researchers. It was attended by 12 junior and senior researchers and members of the Saph Pani project. The main point of concern was the problems faced by women in pursuing their career as well as family life. Both in India and in Europe many women feel they need to choose between the two. Showing that the experienced female researchers also had children revealed that this is not necessarily so. The discussions also highlighted that women do face more issues than male counterparts for working in the field. It bought up a suggestion for not going to field works all alone, be in India or Europe and not to be afraid to request support.

The second meeting was held in Berlin at the Freie Universität Berlin in May 2013. In addition to 8 mainly European researchers the university's womens' officer participated as a guest. Discussions were mainly on how gender mainstreaming is put into practice at the different involved institutions.

The third meeting was planned with the major aspects highlighting the future possibilities and pursuing the career in same field, either leading to doctoral degrees or post-doctoral opportunities. An important aspect of the due authorship in the research articles raised all the participants to another level. The points written in the consortium agreement of Saph Pani, safeguards the due authorship rights of female researchers in the project, thus giving them the credit for the work done.

Even though working in field is not easy for women in Indian scenario, all the female researchers agree that it is an important aspect of their work and should not be neglected. Different strategies are applied to achieve the targets, either being a good manager and getting the work done by subordinates or to build trustful relationships with other researchers to support one another in the field. A useful idea is also to encourage junior female students to participate in field work in order to empower them and make them feel comfortable.

Female researchers of Saph Pani at the Meeting in Mumbai (Nov. 2013)

Two more meetings of the female researcher network are planned for the duration of the project, but we hope that the network will continue to exist also after the completion of the project.

Commissioning of Research Station named "Exploration" on IITB Campus

The Research Station named "Exploration" is based on Constructed Wetland technology has been established on IIT Bombay Campus, India in November, 2013 under the financial grant received from Saph Pani project. The aim of the establishment of this system is to develop the recommendations for how the potential of constructed wetlands systems for wastewater treatment and reuse can be better utilized in India. In last three months, IITB is concentrating on conducting various experiments for treating sewage from IIT Bombay Campus. The treatment system is in the gradual process of stabilization and the changes in the behaviour of its performance is continuously tracking by monitoring the physico-chemical and bacteriological removals in the treated effluent.

Thus, on one hand, the Research Station will help IITB to explore potential ways of enhancing performance of constructed wetland-like natural treatment systems that can hopefully provide economic solution for the problems currently faced while providing sanitation in the remote tribal and rural locations. On the other hand, it is hoped that this approach will demonstrate the significance of constructed wetland as a sustainable and eco-friendly alternative among a plethora of treatment methods that

claim to be providing safe and sustainable technologies to protect water resources in a developing country like India.

Constructed wetland based Research Station established on IIT Bombay Campus, India

German students perform practical semester at IITR

Under the leadership of Prof. Thomas Grischek (HTW Dresden, Germany) the students Reinhard Mink und Sebastian Paufler performed their practical semester in Uttarakhand, India. This internship was conducted from September to December 2013 in cooperation with IIT Roorkee, India. As part of WP1 of Saph Pani, the focus of their work was the collection and evaluation of water samples from BF - sites in Uttarakhand. Within their four month internship, they got the opportunity to visit three BF sites in Srinagar, Nainital and Haridwar with their various characteristics and the different kinds of problems which all have been facing. The observations included the qualitative analysis of the produced bank filtrate as well as the analysis of the efficiency of the local post treatment with chlorine. According to this, the residual chlorine content was determined on-site and the taken water samples were subsequently analysed for E.coli and total coliforms at IIT Roorkee. The data obtained during this internship are a contribution to the ongoing long term observations of this BF sites.

Students of HTWD and IITR in Rorkee

Two day training course on constructed wetlands for wastewater treatment and reuse

Within the frame of the Saph Pani project a two-day training course on constructed wetlands for wastewater treatment and reuse was organized at IIT Bombay in association with NIH Roorkee on the 20th and 21st of November, 2013.

The 74 participants included practicing engineers from industry and municipal corporations, consulting engineers engaged in project design and implementation, graduate students and alumni from IITB as well as regulatory personnel from government agencies.

The excellent program was marked by some highlight speakers such as Dr. Ajay Deshpande from the National Green Tribunal of the Government of India and V.W. Deshpande from the Dhanu Taluka Environmental Protection Authority of the Government of India. Lively panel discussions followed the presentations and opinions of the participants were exchanged.

Participants at the training course

List of Publications

The following publications have resulted from the Saph Pani project so far.

Title	Main Author	Title of the periodical or the series	Number, date or frequency	Year
Riverbank filtration in India – using ecosystem services to safeguard human health	Sandhu, C. & Grischek, T.	IWA journal Water Science and Technology: Water Supply	Iss. 12, vol. 6, p. 783-790	2012
The Promise of Bank Filtration in India	Sandhu C, Grischek T, Kumar P, Ray C	Journal of Indian Water Works Association	Special Issue, December 2012, ISSN 0970-275X, p. 5-12	2012
Development of Riverbank Filtration in Uttarakhand	Kimothi PC, Dimri DD, Adlakha LK, Kumar S, Rawat OP, Patwal PS, Grischek T, Sandhu C, Ebermann J, Ruppert M, Dobhal R, Ronghang M, Kumar P, Mehrotra I, Uniyal HP	Journal of Indian Water Works Association	Special Issue, December 2012, ISSN, p. 13-18	2012
Application of Riverbank Filtration for year-round Drinking Water Production in a small town in the hills of Uttarakhand	Ronghang M, Kumar P, Mehrotra I, Kimothi PC, Adlakha LK, Sandhu C, Grischek T, Voltz TJ	Journal of Indian Water Works Association	Special Issue, December 2012, ISSN 0970-275X, p. 19-24	2012
Environmental Tracer Application and Purification Capacity at a Riverbank Filtration Well in Delhi (India)	Sprenger C, Lorenzen G, Pekdeger A	Journal of Indian Water Works Association	Special Issue, December 2012, ISSN 0970-275X, p. 25-32	2012
Riverbank Filtration: An Alternative to Pre-chlorination	Kumar P, Mehrotra I, Boernick H, Schmalz V, Worch E, Schmidt W, Grischek T	Journal of Indian Water Works Association	Special Issue, December 2012, ISSN 0970-275X, p. 50-58	2012
Nutzung von Aufenthaltszeiten für die Erarbeitung eines Hochwasserschutzkonzeptes für Uferfiltratfassungen in Indien (in English: Use of Travel-Time of Bank Filtrate for the Development of a Flood Protection Concept for Riverbank Filtration Sites in India)	Sandhu, C., Voltz, T., Grischek, T.	Schriftenreihe der Deutschen Gesellschaft für Geowissenschafte	Iss. 78, 2012, p. 78	2012
Challenges to riverbank filtration in Delhi (India): Elevated ammonium concentrations in the groundwater of an alluvial aquifer.	Gröschke, M.	Zentralblatt für Geologie und Paläontologie		2012
Potential of natural treatment technologies for wastewater management in India.	Starkl, M., P. Amerasinghe, L. Essl, M. Jampani, D. Kumarand S. R. Asolekar	Journal of Water, Sanitation and Hygiene for Development	Vol 3 No 4, p. 500-511	2013

Why do Water and Sanitation Systems for the Poor Still Fail? Policy Analysis in Economically Advanced Developing Countries.	Starkl, M., N. Brunner, T.A. Stenström	Environmental Science and Technology	47 (12), p. 6102-6110	2013
Questioning the impact and sustainability of percolation tanks as aquifer recharge structures in semi-arid crystalline conext	Boisson, A., Villesseche, D., Baisset, M., Perrin, J., Viossanges, M., Kloppmann, W., Chandra, S., Dewandel, B., Picot-Colbeaux, G., Rangarajan, R., Maréchal, J., C., Ahmed, S.	Environmental Earth Sciences	online first	2014

Dissemination activities

Two day training course on Natural Systems for Water and Wastewater Treatment and Reuse

The training course will be held at UNESCO-IHE, Delft, The Netherlands, 15th - 16th May 2014

For registration please contact Prof. Saroj Sharma:

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3rd Water Research Conference

The conference will address two main topics:

- Catalytic processes and new materials and technologies in water/wastewater treatment
- Water reuse and product recovery from water/wastewater treatment

Abstracts can be submitted until 1st of August 2014.

11th - 14th January 2014, Shenzen Kylin Villa, Shenzen, China

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