

Proceedings of the
4th National Symposium on Challenges and
Opportunities for Sustainable Management of
Groundwater Resources of Kathmandu Valley, Nepal
22 March 2013



Organized By



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Organized by

Center of Research for Environment Energy and Water (CREEW)

The Small Earth Nepal (SEN)

Environment and Public Health Organization (ENPHO)

Kathmandu Valley Water Supply Management Board (KVWSMB)

In association and supported by: Asian Institute of Technology (AIT) Thailand, International Research Center for River Basin Environment at University of Yamanashi (ICRE-UY) Japan, Kurita Water and Environment Foundation (KWEF) Japan, Asian Institute of Technology and Management (AITM) Nepal, Conservation and Sustainable Use of Wetlands in Nepal/UNDP (CSWN/UNDP), USAID Nepal, Practical Action Office in Nepal, UNICEF

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The organizers sincerely express gratefulness to the opening session chairman Dr. Sanjaya Sharma, Joint Secretary of the WECS; chief guest Er. Kishore Thapa, Secretary of the Ministry of Urban Development; guest Er. Mahendra Gurung, former Joint Secretary of Ministry of Irrigation; and keynote speaker Er. Hari Prasad Dhakal, former Executive Director of Kathmandu Valley Water Supply Management Board.

We like to extend our thankfulness to all the participants from government organizations, universities and research institutes, UN agencies, NGOs, INGOs, Nepal Consumer Association, community drinking water, hotels, housing companies and media and making the symposium interactive and lively.

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INTRODUCTION

BACKGROUND

Groundwater use is the supplementary part of freshwater usage in the world. It holds specific importance in dry areas for domestic, industrial and agricultural sector usage. Groundwater use is increasing at present, causing more groundwater extraction in compare to its recharge which is causing more adverse environmental problems like land subsidence, depletion in groundwater table, groundwater contamination, salt water intrusion etc. Nepal is no exception to these similar problems and issues.

In this context, 4th National Symposium on Challenges and Opportunities and Sustainable Management of Groundwater Resources of Kathmandu Valley, Nepal was jointly organized by Center of Research for Environment Energy and Water (CREEW), The Small Earth Nepal (SEN), Environment and Public Health Organization (ENPHO), and Kathmandu Valley Water Supply Management Board (KVWSMB) in association with Asian Institute of Technology (AIT) Thailand, International Research Center for River Basin Environment at University of Yamanashi (ICRE-JY) Japan, Kurita Water and Environment Foundation (KWEF) Japan, Asian Institute of Technology and Management (AITM) Nepal, Conservation and Sustainable Use of Wetlands in Nepal/UNDP (CSWN/UNDP), UNICEF, USAID Nepal, Practical Action Office in Nepal to mark the World Water Day 2013 as part of the Nepal National Water Week 2013 led by Water and Energy Commission Secretariat (WECS) of the Government of Nepal on 22 March 2013. The theme of the World Water Day 2013 was "Water Cooperation" and slogan was "Water water everywhere only if we share".

Objectives

- To share and be familiar with research activities on groundwater in Kathmandu valley.
- To promote research work and its utilization for management of groundwater.
- To enhance networking, collaborations and cooperation for sustainable management of groundwater.

Themes of the symposium

- Quantitative and qualitative issues of groundwater
- Groundwater use and groundwater market
- Private-public partnership in water supply, groundwater recharge and rainwater harvesting
- Groundwater policy, regulations and institutions

Participants

The stakeholders were personnel from Ministry of Urban Development, KVWSMB, KUKL, Department of Irrigation, universities and research institutes, UN agencies, INGOs, NGOs, Nepal Consumer Federation, and people from community drinking water, hotels, housing companies and media. Total participants of the symposium were 94 (see Annex II).

OPENING SESSION

Welcome speech

The welcome speech was delivered by Dr. Suman K. Shakya (Executive Director, ENPHO). Dr. Shakya welcomed all the guests, participants, presenters, and representatives from different organization to share their valuable knowledge on the "Common Platform" for the better understanding and resolving groundwater problems and issues of the Kathmandu Valley. He also highlighted the importance of groundwater in the Kathmandu Valley.



Keynote speech on "Groundwater issues in Kathmandu Valley"

Er. Hari Prasad Dhakal, Former Executive Director of KVWSMB

The responsibility of managing water & sewerage service in the Kathmandu Valley is taken by Kathmandu Upatyaka Khanepani Limited (KUKL) who has taken the required assets from Kathmandu Valley Water Supply Management Board (KVWSMB) in lease for 30 years. Water Tariff Fixation Commission (TFC) is the regulating body who is responsible for tariff fixation. There are other private sector service providers who basically supply water through tankers. Bulk water users have managed their required supply on their own. KVWSMB is responsible for monitoring the services including GW management. Since many organizations like Groundwater Resource Development Board, Municipalities, Melamchi Water Supply Project, KUKL, Water Industries and NGO's, INGO's are involved in water supply management, groundwater management has become complex.



Kathmandu valley (urban areas) has a total drinking water demand of 350 MLD (million liters per day) whereas the supply is only between 84 and 144 MLD with average supply of 115 MLD creating a big gap of 235 MLD. Most of the gap is met by abstracting groundwater, may it be by responsible supply authority or private sector. Number of service connections now stands at 184,000 and rate of increase in such connections is about 4,500 per year. Looking at the supply indicators, rate of increase in number of connections is decreasing and number of public trips served by tankers of KUKL is slowly decreasing. This shows that private sector is slowly penetrating in the water supply business and they are strengthening their service. The main source of private sector water is GROUNDWATER.

The government has Plans to bring 510 MLD from Melamchi Project in 3 phases of 170 MLD each. The first phase will be completed in 2016 Dec. Before Melamchi is completed new tube-wells will be drilled to abstract 50 MLD of groundwater. It shows that government is still planning to use more groundwater.

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The use of groundwater was negligible before 1975. As population of the valley started growing at a rapid rate the supply became insufficient and both public and private sector started extracting groundwater. In 1980 total extraction was only 6.84 MLD which rose up to 88 MLD in the year 2012. The major users are: KUKL (29 MLD), private tankers (33 MLD), hotels (12 MLD) and government/institutions/ industries (11 MLD).

Due to over abstraction, groundwater level is continuously going down every year. Average rate of decrease is 1 m per year over last 30 years. At some places as much as 2.5 m has gone down per year.

Due to over abstraction, flow in natural stone spouts are affected to a great extent. Out of a total of 389, 45 have disappeared and 68 are not working. Only 233 are functional. Similarly dug-wells have dried already at many places like Kapan, Dhobikhola, Gothatar and Mhepi/Bus Park area. Almost all the sewage generated in the valley is discharged into the rivers so that rivers are converted into sewage channels.

Quality of groundwater is also not good. Deep groundwater contains high amount of iron & ammonia and shallow water is polluted with biological pollution at many places. Arsenic is also found in some deep wells but it is within limit of drinking water as specified by WHO. Anyway neither deep nor shallow groundwater is suitable to drink without treatment. KUKL treats about 80% of its groundwater before supply and the remaining 20% is supplied untreated. Apartments, hotels, hospitals and other bulk users treat water as per their requirements and safety. But in general they do not treat for drinking purpose. However water quality is not monitored by government agencies.

In order to manage groundwater the government has now endorsed a new groundwater management and regulation policy. This policy basically aims to safeguard the fundamental right of the people to access safe drinking water for livelihood, efficiently manage the groundwater so that maximum benefit can be obtained from the resource and extend the life of the aquifer and to design and implement source directed regulatory measures and **licensing** to prevent or minimize the adverse impact of development activities especially with regards to quality and resource potential. Accordingly KVWSMB has prepared some short term and long term implementation program. The short term program include preparation of detail inventory of all existing water sources and prepare GIS data base, carry out research works to identify other water sources, carry out area wise data collection for hydro-meteorological, hydro-geological parameters, demand supply analysis and potential for groundwater abstraction for local distribution, water quality etc., issue of licenses to all groundwater users, identify site specific water resource augmentation measures including rainwater harvesting, explore recharge potential sites and measures to protect the area for the purpose.

In the long term program it has included works like regulate the existing deep wells with respect to location, spacing, aquifer horizon tapped, purpose etc., categorize tariff according to the use and purpose, aquifer horizon and number tapped and totally restrict haphazard groundwater abstraction and drilling, regularly monitor the wells for efficiency, water level fluctuations, water quality and water management aspects, regulate deep well drillings with respect to aquifer potential, location, requirement and priority basis.

There are many problems to implement the policy in general. There are many laws directed towards the management of groundwater. Some of them are: Water Resources Act and Regulations, Water Tax Act, Environment Protection Act and Regulations, KVWSMB Act, and Regulations. There are duplication and un-clarity in these laws. Moreover it is not clear about who is the implementing agency. Furthermore there are technical, social and supply problems.

The latest of the laws is KVWSMB Act, regulations and management policy. There are many challenges to implement the policy by KVWSMB. The most difficult one is the licensing because the service provider is not supplying water as per demand and private sector is emerging for the job that are reluctant to get license and pay tax. Moreover they are in favor of one door policy for tax which seems difficult at this time.

There are many challenges for groundwater management in general. The basic hurdle is the lack of information on groundwater potential, recharge potential, present use and trend of use, use points etc. Monitor Extraction against Permission or Unauthorized Wells and enforcement of law is the next challenging work. Regulate the construction design of tube-wells is also challenging. Water quality monitoring and safety is another crucial field to manage.

In order to acquire basic data some research works would be useful. Some of these would be: water balance study, groundwater inventory (already done), water level study (being done), groundwater flow and yield, potential on hard rock aquifers, rainwater harvesting and recharge, water quality monitoring etc.

Groundwater recharge could well be a tool for groundwater management. In fact the valley receives about 1.165 billion cubic meter of rain per year, 80% of which comes in 4 months. It is estimated that only 15 to 40 MLD (0.46 to 1.22 %) is recharged naturally into the ground. If we consider flow from springs also about 6.6% of it is retained as groundwater. If additional 6% is retained, demand of drinking water in the valley can be fulfilled.

Kathmandu Valley can be divided into three parts considering groundwater and recharge potential. The North Zone has high potential whereas southern and central zones have far less potential. However there may be other pocket areas which must be identified through research. Suitable recharge technology options should also be identified. Considering technology, shallow aquifer recharge methodology could be applied at foothills, pond recharge and recharge through shallow wells could be applied at any other places. Similarly rainwater harvesting could be done in all private and public buildings. The government should also create big open spaces and develop greeneries.

It is recommended that groundwater management and regulation policy be implemented strictly. In this connection licensing, groundwater monitoring, one door policy for groundwater tax, variable rate for domestic and commercial/industrial uses, water level monitoring, water quality monitoring, rain water harvesting, necessary review on existing laws and its implementation should be done. Private sector service should be recognized and monitored.

Remarks by Guest

Guest of the session Mahendra Gurung, President of Nepal Engineers' Association, spoke on the need of utilizing the knowledge and experiences of former technocrats for sustainable management of groundwater in the valley.



Remarks by Chief Guest

Chief guest Er. Kishor Thapa, the secretary of Ministry of Urban Development, shared that Nepal water supply coverage increased to 80% in 2010 against the MDG target of 73% and sanitation coverage reached 43% against the target of 53%. He raised the hope that the Government's target of universal coverage of water and sanitation will be accomplished by 2017. He also highlighted the importance of timely dissemination of research results by researchers and scientist to clear air of terror that often arises at times in Kathmandu valley due to land subsidence linked with excessive groundwater extraction in the valley.



Vote of Thanks

Dr. Rabin Malla (CREEW) expressed sincere thanks to all the distinguished guests, presenters, participants, guests, volunteers and media people for participating in the symposium.



Closing Remarks

Chairman of the inaugural session, Dr. Sanjay Sharma, Joint Secretary of WECS, discussed the importance of groundwater in the context of Kathmandu Valley.



ORAL PRESENTATION SESSION

SESSION I: Groundwater policy, use and management

Chair: Er. Gautam Raj Karnikar

Rapporteurs: Ms. Manisha Thapaliya, Mr. Buddha Bajracharya

Presentation abstract 1: Kathmandu Valley Water Supply Management Board: groundwater management policy, programs and activities

Shambhu Khanal, Kathmandu Valley Water Supply Management Board

Kathmandu Water Supply Management Board (KVWSMB) is an autonomous body established in 2065 under the Water Supply Management Board Act 2063. It takes ownership of the entire water supply asset and properties used by Kathmandu Upatyaka Khanepani Limited (KUKL), make policy and takes overall management of water supply in Kathmandu Valley. KVWSMB has leased assets and properties related to water supply and sewerage to KUKL for 30 years. The tariff for drinking water is fixed by Tariff Fixation Commission.



Groundwater resource constitutes more than 50% water supply in Kathmandu valley. However, there is over-extraction and decline in groundwater level, groundwater pollution, and need for integrated policy for groundwater management. Water Resource Act 2063 and Drinking Water Act 2063 has provision to issue license for groundwater use but the roles and coordination amongst government agencies for groundwater management is not clear. Under this context, KVWSMB has formulated Groundwater Management Policy 2068.

The policy has provision to issue license to extract groundwater depending on volume of extraction, promote community wells for household extraction, categorization groundwater as domestic and commercial use (based on use) and deep wells and shallow wells (based on depth), emphasis on water source protection, encourage grey water reuse and recycling, translocation of industries that over-extract groundwater, discourage groundwater extraction along river corridors, etc.

The board has some programs for detailed groundwater inventory, restoration and conservation of water sources, campaign to make license compulsory for deep groundwater users and orient them for groundwater management, identification of potential areas for rainwater harvesting and groundwater recharge (e.g. Recharge Kathmandu Campaign), etc.

Some major activities by the board are to monitor the services provided by KUKL and other service providers, implementation of groundwater management policy 2068, resource mobilization for construction of feasible projects, coordination with ministries and other line agencies, study and research for groundwater source management (monitoring, licensing and developing inventory of wells), formulate policy on rainwater harvesting and design rainwater collection technology, operation and security plan formulation for land received from Melamchi, installation of 680 KWp Solar Energy System in Dhobighat, capitalized construction work planning, approval and fund release, and work related land ownership of KVWSMB.

Presentation abstract 2: Evolution of groundwater markets in Kathmandu Valley: An analysis of market mechanisms

Shreya Bajimaya, Robert Dongal, Nepal Engineering College, Baikhu, Kathmandu

This study was carried out with the aim of characterizing the groundwater market in Kathmandu, water transactions involved, and the contributions of groundwater market in easing water scarcity. The study identified four forms of groundwater markets operating at different levels based on the volume of water transactions, level of investment in the business and sophistication in the infrastructures and technology adopted for water extraction, storage, treatment and distribution. These include: Small scale groundwater vending, community based groundwater distribution, commercial scale groundwater market, and Industrial scale groundwater market.



The study noted that the water market mechanism operating at small scale and community based were addressing the water needs of low income residents and houses whose daily water demands are low while commercial scale groundwater markets operating largely in the form of private water tankers bear significantly large level of investment and the sophistication in the infrastructures and technology.

Presentation abstract 3: Rainwater for aquifer recharge: the RC Yala experience
Pramod Pradhan, Asian Institute of Technology and Management (AITM)

The Rotary Club of Yala, Lalitpur prepared a list of 20 community schools with good potential for recharging aquifers. Out of these, six schools were selected as pilot sites based on their geographical spread and availability of dug well in their vicinity. These are: YMBA International Buddhist School at Etee Tole, Tri Padma School at Pulchowk, Sri Chandi School at Chakupat, Sri Shanti School at Lonlaa, Prabhat School at Gwarko, and Adarsh Kanya School at Mangalbazar. Besides, the Patako Chowk behind Patan Krishna Mandir was also selected as community courtyard to demonstrate the rainwater use for aquifer recharge. Since most of these recharge systems had been constructed in non-rainy season, we thought that the effectiveness will be demonstrated only during the upcoming rainy season. Fortunately, the first recharge system built at YMBA International Buddhist School successfully demonstrated its effectiveness as there was 3 days heavy winter rainfall right after its construction. The well there, that used to produce hardly 5-10 liters a day, was delivering almost 200 liters of water for following two weeks. It's definite that this will be functional throughout the year once it passes this year's rainy season. Its huge recharge area of over 10,000 square feet will percolate more than 1.5 million liters of water down the aquifer. The soak pit made of 22 concrete rings filled with boulders, coarse and fine sands is 16 feet deep and about 20 feet far from the adjoining well. The rainwater from roof tops and courtyard is clean, and is also used to fill its underground water tank that supplies water for sanitation, cleansing and bathing purposes. The underground geology of Sri Chandi School, Sri Shanti School, Adarsh Kanya School and Patako Chowk is similar to YMBA International Buddhist School. In Tri Padma School and Prabhat School, sandy soils were met at 22 feet and are inferior in comparison to above ones.



Open Discussion

In response to the question asked from the floor, Er. Khanal replied that microbial and chemical safety is two different aspects of drinking water and a specific area cannot be delineated. Even within the same area, some water may be safe but other water may not be safe. It also depends upon the age and the design of the groundwater system. Another question was put forward by an audience about the criteria for getting the license of the deep wells. Er. Khanal said recently there are no such criterions made by the government. But in the future there is a plan for making such criteria.

Similarly, after completing the presentation Mr. Dongol was asked when his research was conducted and who monitors the quality of drinking water being sold by vendors. Mr. Dongol replied that the study was conducted in 2011 and the water supplied by the vendor is not monitored by anyone but fortunately few vendors treat water before selling.

One of the participants raised queries to Mr. Pramod Pradhan about the cost of constructing recharge system for a well, sustainability of the aquifer recharge program and how much will you contribute? Mr. Pradhan replied that the cost of constructing a recharge system for a well depends upon the depth of the well. Usually, for a 15 to 20 ft deep well the cost is around Rs. 40,000. For sustaining the aquifer recharge program, regular monitoring system has been conducted and 50% of the money will be diverted to construct 15,000 toilets in different part of the country as there are very few gender friendly toilets in Nepal and this has led to dropping out of school by girls after a certain age. One of the participants advised Mr. Pradhan to be careful when dealing with water and sewage for the toilet project.

SESSION II: Groundwater quantity
Chair: Prof. Dr. Narendra Man Shakya
Rapporteurs: Ms. Aradhana Deoju, Mr. Dibit Aryal

Presentation abstract 1: The shallow groundwater system in Kathmandu Valley - it's potential as a sustainable solution to address the water problems

Suresh Das Shrestha, Central Dept. of Geology, TU

The state water supply manages to fulfill only about 33% of the demand. Thus, most households in Kathmandu valley have an alternative source of water supply which taps the shallow groundwater system. Assuming even only 37% of the deficit is fulfilled; it totals up to 118 MLD. The best part is the system is naturally recharged during monsoon. However the recharge is in decline.



The shallow aquifers consist of mainly gravel sand and silt of thickness ranging from 20-60 m. With more potential in the northern areas compared to the south. 35 spring sources in the south-western parts of the valley have an estimated discharge of 43 MLD. As the subsurface geology, rainfall pattern has not changed over the years; the shallow aquifer system has the potential to address the water supply needs of the valley.

Total storage capacity is estimated at 3031 MCM. Total annual rainfall in the valley is estimated at 1140 MCM. Total water demand in the valley is 102 MCM (9% of the rainfall). Past data of few wells show average yearly water level fluctuation of 2 m in Patan. Assuming same for entire valley, the yearly recharge will amount to 138 MCM (12% of rainfall).

As the natural recharge is in decline, the demand for more water can only be fulfilled through artificial recharge through rain water harvesting (RWH) and rainwater recharge (RWR).

Presentation abstract 2: Groundwater modeling using a fully distributed, physically based surface sub-surface integrated model

Pallav Kumar Shrestha, Institute of Engineering, TU, Pulchok

The antecedent soil moisture conditions play a great role in the occurrence of landslides. Population increase, especially toward the landslide prone marginal hills of Kathmandu Valley, warrants for a study that can address the hazard probability at the valley rim. Few distributed groundwater model have been applied in the study area and its application for landslide analysis is even rarer. The handful of previous works on landslides correlate rainfall with landslides while the resulting position of groundwater table was not found to have been correlated to landslides.



The physically based distributed modeling system, SHETRAN, is parameterized for the Kathmandu Valley, and used to develop a robust groundwater model which provided reliable time series estimates of phreatic surface elevations, moisture content and soil potential in the subsurface. The coefficient of correlation between measured and simulated phreatic surface elevations for overall simulation was 0.81 with a probable error of 0.05 and standard error of 0.074. This was an improvement over previous attempt of groundwater modeling of the catchment. The model success was further reinforced by outlet discharge check showing a Nash Sutcliffe Efficiency of 0.79 for the calibration period and 0.73 for the validation period. This validated model is capable of providing the subsurface moisture conditions which can be correlated with the past landslides to develop a landslide hazard map for various meteorological scenarios. The model also looks promising for its application in contamination analysis and study of future groundwater availability in the Valley.

Presentation abstract 3: Groundwater extraction: implications on local water security of peri-urban Kathmandu

Anushiya Shrestha¹, Rajesh Sada¹, Kanchan Karki² and Ashutosh Shukla¹

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The rapid and haphazard urbanization in Kathmandu valley and expansion of built-up area to the peripheral rural landscapes has resulted to formation of peri-urban areas which are now themselves transforming into urban form. This paper examines how the increasing urban water demand has put unprecedented pressure on groundwater resources in the peri-urban areas of Kathmandu valley.



Based on the semi-structured interviews with local people, focus group discussions and key informants interviews, the study found that water security at Jhaukhel is closely associated with groundwater and the dependency of local people on groundwater has increased over the years. The implications of the groundwater extraction coupled with sand mining in the area have been manifested in form of declining groundwater table and drying of traditional water sources. Despite the growing awareness among the local people on the consequences of depleting groundwater table, in absence of strict regulatory mechanism, the exploitation of groundwater has been adding threat to the local eco-hydrology of the area and subjecting the local community to water insecurity.

Open Discussion

In response to the question regarding any advice to the huge groundwater extractors like industries in contributing to putting less pressure on groundwater resource Prof. Dr. Suresh Das said that the industry people are being made aware of the grave situation of the groundwater in the valley and the government is possibly in the process of advising them to reduce dependency on the groundwater. He was also asked if sand mining was affecting the groundwater recharge, he responded by saying that sand can increase the recharge compared to clay.

One of the participants asked Mr. Pallav Kumar Joshi if the modeling system SHETRAN could be used for modeling the effect of river water pollution in contaminating the groundwater sources. In his answer, Mr. Joshi replied that for modeling one should have detailed data on the real scenario like soil profile, types and depth of soil and aquifer. If such data and point of pollution is known, it can be used for identifying the effect.

SESSION III: Groundwater quality

Chair: Dr. Dhundi Raj Pathak

Rapporteurs: Ms. Sujata Shrestha, Mr. Binay Sakanu

Presentation abstract 1: A study on the composition of sewage discharged into rivers of Kathmandu Valley and the role of sewage management in groundwater protection

*Rabin Shrestha, Pramina Nakarmi, Prajwal Shrestha and Suman K. Shakya
Environment and Public Health Organization (ENPHO),
Kathmandu*

Kathmandu is a rapidly urbanizing city with a population of almost three million and is facing increase in problems related with availability of drinking water, its quality and wastewater management. The wastewater production in Kathmandu has increased significantly due to the increase in the population, unplanned urbanization, rapidly changing water consumption behavior and change in the living standard of the people.



In Kathmandu, generally the wastewater (raw sewage) from communities is directly discharged into the river stream through municipal drainage system. This results in the severe degradation of the water quality of the river stream or watershed as a whole and can also have negative impact on ground water quality. In order to treat the wastewater or to identify its re-use potential it is essential that the composition of the wastewater is known. In this context, this paper presents the compositional data of wastewater drained into different river streams (Bagmati, Bishnumati, Dhobikhola and Manohara Rivers) around Kathmandu valley. This study is directed towards highlighting the importance of sewage treatment in order to protect surface and ground water resources. To determine the wastewater composition, composite samples of the wastewaters were collected along different wastewater discharge point along river streams. Based on laboratory analysis, the tested water quality parameters were found to be exceeding the Nepal Standard Guidelines for Wastewater Discharge in Inland Surface Water as stated by Ministry of Population and Environment (MoPE), Nepal (2001). Comparing the measured values with the standard tolerance limits for different industrial effluents discharged into inland surface water (Generic 1) as stated by MoPE (2001), Biological Oxygen Demand (BOD) values were found to be around 3 - 16 times higher whereas Chemical Oxygen Demand (COD) values were found to be around 2.5 -12.5 times higher compared to the standard values. Likewise, Total Suspended Solids (TSS) values of most of the samples were found to exceed the guidelines with the highest value around 8.5 times higher than the guideline. pH and temperature of all the sample points were found to be within the tolerance limits. Ammonia- nitrogen values of the some sample points were within the tolerance limit whereas others exceeded the tolerance limit value by 7.5 times at most. Besides, chloride, total phosphorus, total nitrogen, nitrate and nitrite of wastewater were also measured. The higher values of these parameters also indicate the severe pollution level of the wastewater. Thus, from this study, it can be concluded that the sewage wastewater currently being discharged into the rivers of Kathmandu valley is highly polluted and consequently degrading the water quality of the rivers. In Kathmandu valley, wastewater is also used for irrigation purpose and this could also lead to ground water pollution. Different studies show that river pollution can have direct impact on the both quality and quantity of the ground water resources.

Presentation abstract 2: Heavy metal distribution in deep groundwater resources of Kathmandu Valley, Nepal

Suman Man Shrestha, Central Department of Environment Science (CDES), TU

A study was conducted in forty-one deep groundwater wells of Kathmandu Valley, Nepal to assess heavy metal distribution and relationships between pH, EC and heavy metals. Groundwater samples were collected during pre-monsoon season in 2012. Atomic absorption spectrometer (AAS) was used to measure the concentration of iron (Fe), manganese (Mn), zinc (Zn) and arsenic (As). The maximum concentrations of Fe, Mn, Zn and As measured were 17.9 mg/L, 1.04 mg/L, 0.95 mg/L, 0.143 mg/L respectively.



There is strong positive correlation between Fe and Mn concentration ($r = 0.701$, $p < 0.01$) suggesting common origin of these metal in groundwater. Arsenic is positively correlated to Mn and Fe ($r = 0.492$, $p < 0.01$; $r = 0.373$, $p < 0.05$). Negative Correlation of Oxidation reduction potential (ORP) with Fe, Mn, As ($r = -0.555$, $p < 0.01$; $r = -0.466$, $p < 0.01$; $r = -0.540$, $p < 0.01$) showed reductive metal mobilization mechanisms in deep groundwater wells. The central groundwater district has a higher reducing environment than northern and southern groundwater district. The mapping of spatial distribution of EC and heavy metal concentrations (Fe, Mn, Zn and As) in groundwater was performed using Arc GIS 9.3. The EC and heavy metal concentrations varied spatially with high concentration in central groundwater district. Based on the similarities in groundwater quality, the groundwater wells in central groundwater district was characterized as groundwater wells of high mineralization and groundwater wells of northern and southern groundwater district characterized as groundwater wells of low mineralization.

Open Discussion

One of the participants asked Mr. Rabin Shrestha the number of season samples were taken. He mentioned that the samples were taken only once due to time constraints. Another participant was interested to know the reason behind high value of temperature of the samples. Mr. Shrestha replied that it may be due to the location variation. He further mentioned that as the samples of one season were only tested so no comparisons could be made.

One of the participants asked questions to Mr. Suman Man Shrestha regarding the presence of Iron (Fe) in the samples. He was interested to know the impacts of Fe in drinking water. Mr. Shrestha replied that Fe in the samples was within the permissible level and Fe does not have much deleterious effect on human body. He also told that changes in water color and precipitations are the major problems for iron containing water. On a query about whether the depth and location of the wells had any significance, Dr. Shrestha replied that depths of the wells were not significant with the location but it was closely related to geology of valley.

SESSION IV: Stakeholder discussion on groundwater/water supply in Kathmandu Valley
Panelist: Asso. Prof. Suresh Das Shrestha, Er. Tilak Mohan Bhandari, Er. Shambhu Raj Khanal
Moderator: Dr. Vishnu Prasad Pandey
Rapporteurs: Ms. Maneesha Shakya, Ms. Nicky Shrestha

Presentation abstract 1: Problems and issues of groundwater in some Asian and developed countries

*Sangam Shrestha, AIT; Rabin Malla, CREEW;
Vishnu Prasad Pandey, ICRE-UY*

The objective of this paper was to get familiar with some aspects of ground water problems and issues and management in some selected Asian countries viz. Nepal, India, China, Sri Lanka, Vietnam, Bangladesh, South Africa, Thailand and a developed country viz. Australia and share



with the groundwater stakeholders of Kathmandu Valley at the symposium. Literature review was done to collect the information. Groundwater management bodies, law, policy and regulation for groundwater management were in place in all these countries. Groundwater quality was commonly in the land areas due to iron, ammonia, nitrate, arsenic, and bacterial pollution of fecal coliform and total coliform. Metallic pollution of groundwater was reported to be found in



China, India, Sri Lanka, Vietnam, Thailand and Australia. Radioactive elements were also present in Chinese groundwater. Fluoride was common problem in India, Sri Lanka, and South African groundwater. Salinity intrusion into groundwater was an issue in the coastal areas of these countries. South Africa and Australia faced groundwater contamination with chemicals and toxin and pesticides.

Groundwater level was reported to be falling depending on the extent of groundwater extraction in all the countries. Thailand in Bangkok has managed to control groundwater extraction by charging for groundwater use and its preservation. It was found that in Launcheng County of China to address the problem of groundwater depletion and land subsidence, evapo-transpiration techniques from field was adopted such as changing land use pattern (e.g. mulching agricultural land, adopting greenhouse system), changing cropping pattern (short duration cropping, leaving the land fallow) and, using rainfall for artificial aquifer recharge.

Groundwater treatment for drinking was reported for different parameters. Arsenic was removed using bio-sand filter, two Gagri and three Gagri systems, Kanchan Arsenic Filter, SONO Filters and, potassium permanganate treated raw water with activated charcoal for slurry absorbent and sand filtration. For irrigation water, arsenic was removed by planting ferns (*Pteris vittata*) and blue green algae in arsenic contaminated top soil to absorb arsenic from groundwater. Iron was removed by treating the groundwater with potassium permanganate and then filtering through sand filters. For the removal of fluoride, ion-exchange resin (slurry of cerium hydroxide) and absorbent (activated charcoal and activated alumina) have been used, while others have used bauxitic clay as fluoride absorbent. Nitrate in groundwater has been removed by permeable reactive barrier (PRB) that consists of physical/chemical barrier supplied with reactive parts. Phyto-remediator plants like *Diopyrus*, *Calophyllum*, *Vitex*, *Madhuca*, *Beryaare* used for nitrate removal and deep rooted perennial plants are also being used to remediate nitrate from shallow well during drought.

Open discussion agendas: (1) Existing groundwater management problems/issues (2) Future plans/strategies/activities for water supply and management

After the presentation meant for sharing groundwater management in Asian countries and some developed countries and then to stimulate the open discussion, the session had major discussion and some of the excerpts are provided below:

Dr. Vishnu Prasad Pandey asked a question to Dr. Suresh Das Shrestha regarding the knowledge of groundwater resources whether we lack knowledge or knowledge management in case of groundwater resources and what would be the ways for better management of knowledge? In response to his query, Dr. Shrestha answered that there is lack of data regarding the groundwater resources. He mentioned that there are very few experts working in the groundwater sector than in the surface water. Besides that, he emphasized that regular monitoring of the groundwater resources is a must. Regarding the ways of better management of knowledge, Dr. Shrestha said that the problems regarding the groundwater resources should be understood, people should be made aware and solutions of the problems should be sought for. Further, he stressed on educating the people on proper use of available water resources.

In reference to the keynote speech on "Groundwater issues in Kathmandu valley" given by Er. Hari Prasad Dhakal, a question was raised to Er. Shambhu Raj Khanal whether the groundwater policy recognizes private sectors or not. Mr. Khanal explained that the Government of Nepal is not able to provide drinking water supply and therefore one must rely on the private sectors such as tankers.

Mr. Shambhu Kadariya, representative of Nepal Upavokta Mahasang (Nepal Consumers Federation) raised a query about provision of license to tankers. He shared that KUKL do not even have enough data about the taps connected. Tankers are one the important sources of water for several households. The tax taken by government for tanker should be nominal. If taxes are taken in exorbitant rates then private sectors (tankers) may protest and this would lead to deprivation of water supply to several households who are solely relied upon tankers. To the question raised by a participant, regarding the management of byproducts after the treatment of water, it was known that in some cases, the byproducts are kept in sludge tank whereas in others they are discharged to sewers. Dr. Dhundi Raj Pathak shared his experience about his research on water quality done in 2008. He used Cadmium reduction method to find out the nitrate present in the sample. Cadmium was the byproduct and there was no any way of disposing Cadmium here at Nepal so he took it to Japan for disposal. Therefore, from this experience Dr. Pathak emphasized that managing the by product is essential.

A query was raised by Dr. Vishnu Prasad Pandey whether there is consensus between all the experts or not. Dr. Suresh Das Shrestha answered that there was a meeting of groundwater experts on July 2009 and he also suggested that experts should sit and make standards regarding the deep and shallow sources. He also mentioned about the book "Kathmandu Valley Groundwater Outlook".

Mr. Kadariya told that groundwater is an important source of water and suggested that ways should be paved for proper management and there should be clear vision about water supply and regulations. Moreover, the KVWSMB should take initiation for regulations and waste water management. Mr. Kadariya further added that KUKL should not be dependent entirely on other organizations and must be made active for water sources. Similarly, the Tole Sudar should be given priority at ward level for water and wastewater management.

One of the participants raised a question to Er. Tilak Mohan Bhandari, the reasons KUKL could not mobilize water resources for proper water supply while the private sectors are using the same resources effectively. Mr. Bhandari explained the existing condition of KUKL that only 17 tankers are providing services on behalf of KUKL whereas 800 tankers are actively providing services to the people in the valley. One more question asked to Mr. Bhandari about the quality controls of the tankers and who should be responsible? The water service provided by the tankers should be given license by the KVWSMB. The quality of water must be analyzed in laboratory and the final water quality should be under the Nepal standard. He explained that there should be different tankers for different purpose. The tanker used for the deep boring water for the purpose of building houses should not be used for providing drinking water.

The discussion was concluded that existing major problem regarding groundwater is inadequate information on it and haphazard withdrawal. For the proper management of the groundwater in future, focus should be given to the consumptive use; priority should be given in data generation and knowledge management. For better water supply and management, service from private sectors should be recognized and properly managed.



CLOSING SESSION

Mr. Sudarshan Rajbhandari, Vice President of SEN gave his closing remarks by thanking all the people who made valuable scientific paper presentations, participants of the symposium from government, universities and research institutes, UN agencies, INGOs and NGOs and other relevant water stakeholders.



ANNEX I: PROGRAM SCHEDULE



4th National Symposium on Challenges and Opportunities for Sustainable Management of Groundwater Resources of the Kathmandu Valley, Nepal
22 March, 2013

Date: 22 March 2013

Venue: Hotel Himalaya, Kupondole

Registration: 8:45-9:00

MC: Ms. Nicky Shrestha

OPENING SESSION

9:10-9:15	Welcome address	Dr. Suman K. Shakya, Executive Director, ENPHO
9:15-9:30	Keynote speech on "Groundwater issues in Kathmandu"	Er. Hari Prasad Dhakal, Former Executive Director, Kathmandu Valley Water Supply Management Board (KVWSMB)
9:30-9:45	Video spot presentation	Conservation and Sustainable Use of Wetlands in Nepal (CSWN)
9:45-9:50	Remark by Guest	Er. Mahendra B. Gurung, President of Nepal Engineer's Association
9:50-10:00	Remark by Chief Guest	Er. Kishore Thapa, Secretary, Ministry of Urban Development (MoUD)
10:00-10:05	Vote of thanks	Dr. Rabin Malla, CREEW
10:05-10:10	Session close with concluding remarks by Chairperson	Dr. Sanjay Sharma, Joint Secretary of Water and Energy commission Secretariat (WECS)
Photo Session and Tea Break (10:10-10:25)		

SESSION I: Groundwater policy, use and management (12min for presentation and 3min for discussion)		
Chair: Er. Gautam Rajkarnikar Rapporteurs: Ms. Manisha Thapaliya, Mr. Buddha Bajracharya		
10:25-10:40	Kathmandu Valley Water Supply Management Board: groundwater management policy, programs and activities	Er. Sambhu Khanal, Kathmandu Valley Water Supply Management Board (KVWSMB)
10:40-10:55	Evolution of groundwater markets in Kathmandu Valley: an analysis of market mechanisms	Asst. Prof. Robert Dongol, Nepal Engineering College, Balkhu
10:55-11:10	Rain water for aquifer recharge: the RC Yala experience	Mr. Pramod Pradhan, Asian Institute of Technology and Management (AITM)
SESSION II: Groundwater quantity (12min for presentation and 3min for discussion)		
Chair: Prof. Dr. Narendra Man Shakya Rapporteurs: Ms. Aradhana Shrestha, Mr. DibitAryal		
11:10-11:25	The shallow groundwater system in Kathmandu valley - its potential as a sustainable solution to address the water problems	Asso. Prof. Suresh Das Shrestha, Central Dept. of Geology, TU
11:25-11:40	Groundwater modeling using a fully distributed, physically based surface sub-surface integrated model	Mr. Pallav Kumar Shrestha, Institute of Engineering, TU, Pulchok
11:40-11:55	Groundwater extraction: implications on local water security of peri-urban Kathmandu	Ms. Anushiya Shrestha, Nepal Engineering College, Balkhu
Break (11:55-12:05)		
SESSION III: Groundwater quality (12min for presentation and 3min for discussion)		
Chair: Dr. Dhundi Raj Pathak Rapporteurs: Ms. Sujata Shrestha, Mr. Binay Sakanu		
12:05-12:20	A study on the composition of sewage discharged into rivers of Kathmandu Valley and the role of sewage management in groundwater protection	Mr. Rabin Shrestha, Environment and Public Health Organization (ENPHO)
12:35-12:50	Heavy metal distribution in deep groundwater resources of Kathmandu Valley, Nepal	Dr. Suman Man Shrestha, Central Dept. of Env. Sc. (CDES), TU
Lunch (12:50-01:40)		
SESSION IV: Stakeholder discussion on groundwater/water supply in KTM valley		
Panelist: Asso. Prof. Suresh Das Shrestha, Er. Tilak Mohan Bhandari, Er. Shambhu Raj Khanal Moderator: Dr. Vishnu Prasad Pandey Rapporteurs: Ms. Maneesha Shakya, Ms. Nicky Shrestha		
01:40-01:55	Problems and issues of groundwater in some Asian and developed countries	Dr. Rabin Malla, CREEW
01:55-02:30	Discussion agendas: (1) Existing groundwater management problems/issues (2) Future plans/strategies/activities for water supply and management	
CLOSING SESSION		
02:30-02:35	Session close with remarks	Mr. Sudarshan Rajbhandari (SEN)

ANNEX II: List of Participants

S.N.	Name	Organization
Government organizations		
1	Er. Kishor Thapa	Secretary, Ministry of Urban Development
2	Dr. Sanjay Sharma	Joint Secretary, WECS
3	Er. Bharat K. C.	HPCIDBC
4	Er. Kalyan Singh Thapa	Act. General Manager, KUKL
5	Er. Gautam Raj Karnikar	Deputy Director General, DHM
6	Er. Tilak Mohan Bhandari	Manager, KUKL
7	Er. Ramesh Man Pradhan	Branch Manager, KUKL, Lalitpur
8	Yogendra B. Bam	Sr. Admin. Officer, KVWSMB
9	Ram Chandra Dhakal	Finance Officer, KVWSMB
10	Sushil KC	KVWSMB
11	Er. Sambhu Khanal	KVWSMB
12	Shishir Koirala	WECS
13	Pramod Raj Sharma	Groundwater Resource Development Board (GRDB)
14	Surendra Raj Shrestha	GRDB
15	Er. Narendra Khattri	Dept. of Irrigation, Jawalakhel
16	Bal Bdr. Thakurathi	KVWSMB
Academic/research institutions		
17	Prof. Dr. Narendra Man Shakya	Institute of Engineering (IoE), TU
18	Asso. Prof. Dr. Suresh Das Shrestha	CDG, TU
19	Dr. Vishnu Prasad Pandey	University of Yamanashi, Japan
20	Amresh Karmacharya	ASCOL
21	Asst. Prof. Suman Man Shrestha	Central Dept. Env. Sc., TU, Kirtipur
22	Prof. Dr. Subodh Sharma	Kathmandu University, Dhulikhel
23	Asst. Prof. Kundan Lal Shrestha	Kathmandu University, Dhulikhel
24	Asso. Prof. Dr. K. N. Dulal	Kantipur Engineering College/CREEW
25	Prof. Dr. Ayohko	University of Yamanashi, Japan
26	Er. Utsav Bhattarai	Kathmandu University, Dhulikhel
27	Prof. Dr. Khem Raj Sharma	nec-CPS
28	Robert Dongol	nec-CPS
29	Anushiya Shrestha	nec-CPS
30	Dr. Dhundi Raj Pathak	Director/ Principal, researcher, Engineering Study & Research Center, Kathmandu
31	Pallav Kumar Shrestha	IOE
32	Harshana Shrestha	AIT
33	Pramod Pradhan	AITM
34	Mr. Madan Pd. Lamichhane	Prop. Cum Consultant Geo-Hydrologist
35	Yogendra Budha	SchEMS
36	Pratap Maharjan	SchEMS

37	Rajeev K. Singh	University of Tsukuba
38	Manju Joshi	CDES, TU
39	Hemraj Bhattarai	SchEMS
40	Dr. Manohar Lal Shrestha	Director/Japan Nepal Think Tank Institute
41	Shrijana Gurung Shrestha	Pulchowk College, IOE
42	Nabin Bhandari	SCHEMS
UN agencies and international organizations		
43	Knapp Andrses	UNICEF
44	Arinita Maskey Shrestha	UNICEF
45	Mr. Bhushan Tuladhar	Technical Advisor, UN-Habitat Nepal
46	Dr. Ram C. Bastakoti	Researcher, IWMI Nepal
47	Mr. Raju Khadka	Oxfam Nepal
48	Dr. Laxman Joshi	SNRM/ICIMOD
49	Mrs. Yoko Oda Thapa	AMDA-Minds
NGOs and others		
50	Er. Mahendra Gurung	Himalaya College of Technology
51	Er. Hari Prasad Dhakal	Former Executive Director, KVWSMB
52	Er. Ganesh Shah	HIMMCA
53	K P Sharma	JVS
54	Dr. Rabin Malla	ED, CREEW
55	Dr. Suman K. Shakya	Executive Director, ENPHO
56	Aradhana Shrestha	CREEW
57	Uddhav Madai	CREEW
58	Dibit Aryal	ENPHO
59	Padmaja Shrestha	ENPHO
60	Sudarshan Rajbhandari	Vice President, SEN
61	Niranjana Bista	SEN
62	Maneesha Shakya	CREEW
63	Rabin Shrestha	ENPHO
64	Pramina Nakarmi	ENPHO
65	Jeeban Panthi	SEN
66	Nicky Shree Shrestha	SEN
67	Binay Sakanu	SEN
68	Sudip Thapa	PashimPaila
69	Manisha Thapaliya	ENPHO/ Pachimpaila
70	Buddha Bajracharya	PashimPaila
71	Er. Guheswori Tuladhar	UEMS
72	Mr. Bishnu Dahal	Valley Drinking Water and Tanker Entrepreneurs Association
73	Mr. Shambhu Kadaria	Nepal Consumer Federation
74	Mr. Ashok Niroula	Stakeholder/Consumers
75	Mr. Yogendra Rumba	Soaltee Hotel Ltd.
76	Kiran Bhusal	CFCCN
77	Zwaag R.	One Planet Solution
78	Suman Shakya	One Planet Solution

79	Rajani Maharjan	Smart Paani
80	Nirmal Prabha	
81	Isha Dhakal	CCFCN
82	Arjun Adhikari	Nepalbani Network
Media		
83	Roshan Thapa	Araniko TV
84	Bhawana Gurung	Radio Sagarmatha
85	Binay Banjara	Abhiyaan Daily
86	Shailendra Govinda Amatya	Avenues TV
87	Bishnu Khadka	Avenues TV
88	Kasita Adhikari	Nepal 1 TV
89	Shankar Khanal	Image TV
90	Laxman Dongol	Image TV
91	Rikesh Singh	Nepal 1 TV
92	Deelipa Adhikari	Sagarmatha TV
93	Ram Chitrakar	Sagarmatha TV
94	Sabin Sharma	Rajdhani Daily

ANNEX III

Technical Committee

Asst. Prof. Dr. Sangam Shrestha (AIT), Prof. Futaba Kazama (ICRE-UY), Dr. Vishnu P. Pandey (ICRE-UY), Asso. Prof. Dr. Suresh D. Shrestha (TU), Dr. Suman K. Shakya (ENPHO), Mr. Dhiraj Pradhananga (SEN & Centre for Hydrology-Uof S)

Organizing Committee

Dr. Rabin Malla (CREEW), Ms. Maneesha Shakya (CREEW), Mr. Sudarshan Rajbhandari (SEN), Mr. Piyush Dahal (SEN), Mr. Niranjana Bista (SEN), Ms. Kabita Gautam (SEN)



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