INTEGRATED WATER RESOURCE MANAGEMENT FOR COMMUNITY BASED CLIMATE CHANGE ADAPTATION

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ABSTRACT

India has developed to a water stressed scenario in the last decades and is on its way to a water scarce scenario in near future. Climate Change affects the quantity and quality of available water sources for various usages. Water Supply, Agriculture and Ecosystems have to face new challenges. Vulnerable communities have to adapt to the changing circumstances to cope with the situation. With Integrated Water Resource Management (IWMR) the various sectors of public and private water users can work out sustainable approaches to foster development and prosperity while taking into account the changing circumstances. Especially small rural communities with their livelihoods directly dependent on local natural resources are in urgent need to implement IWRM strategies in order to address climate changes. The presented case study has worked out an integrated approach to address the needs of the various community groups consisting of farmers, fishermen and daily labourers. The self-governing local bodies together with self-help groups, NGOs and representatives from the various economic stakeholders have developed several up gradation measures for their water resources and the water supply system addressing projected climate change impacts. Changing water demand and ecological impacts have been taken into account. Catchment protection and pollution prevention measures have been worked out for the river basin, which is the source for the water supply scheme. In cooperation with state departments and district authorities a long term solution for a safe and sustainable water supply is being elaborated for meeting the demands and necessities of all stakeholders in the river basin.

INTRODUCTION

Water is becoming scarce in India. India's utilisable amount of water sources is 1123 km³ of which 690 km³ are surface water and 433 km³ are ground water. The water demand for the year 2000 was estimated with 634 km³ of which 541 km³ was used for irrigation, 42km³ were used for domestic needs and 51 km³ for industry, energy and others. (1)

According to these figures it seems India is having more than enough utilisable water. Looking at it from a different point of view India at present with a population of 1.21 Billion as per census 2011 has a per capita water availability of 1544 m^3/year compared to 1967m^3/year in the year 1997. In international norms in the past 14 years India has thus developed to a water stressed scenario (>1700 m^3/person/year). For the future with the UN middle variant of population growth India is assumed to have a population of 1.64 Billion on 2050 and thus an per capita availability of 1140 m^3/year which is near to a water scarce scenario (<1000 m^3/person/year). These are average values for a very diverse subcontinent, many pockets in India are already water scarce now and others have a surplus of available water which is not used properly.

Apart from the scarcity India's water sources have a variety of quality problems. Man-made contamination comes from sewage disposal, agricultural runoff and industrial effluents, leading to various organic and inorganic contaminations. Due to surface water quality deterioration in the last century, groundwater usage has emerged as a promising solution. In India, nowadays around 80% of the rural population is dependent on groundwater to meet their domestic needs. But in many areas groundwater quality does also not meet drinking water standards. In addition to anthropogenic pollution sources groundwater is often burdened by geological contamination. Natural contamination is related to arsenic, salinity, fluoride and iron. Although natural by source, the occurrence or mobilisation is also triggered by anthropogenic activities mainly the over extraction of groundwater. Overall 33% of the countries groundwater sources are unfit for consumption (6).

Rapid development has taken up in the last decades in India, still safe access to drinking water has not reached the whole population. 90% of rural households still depend completely on untreated surface or groundwater (2). These untreated sources do not necessarily have to be contaminated but numerous health impacts related to the consumption of unsafe water have been reported (3). The regular intake of contaminated water leads to serious diseases. Studies estimate that about 21% of communicable diseases in India are water related (4). Children under the age of five suffer mostly from diarrhoea often causing their early death (5). The health problems are also related to socio-economic consequences, leading to poverty, exclusion and marginalisation. In addition to the direct anthropogenic and the geogenic impact on the availability of clean water sources the indirect impact through climate change further aggravates the scenario and calls for an efficient usage and management of the valuable and limited resources.

WATER RESOURCE MANAGEMENT AND CLIMATE CHANGE ADAPTATION

Traditional water resource management in the rural area was based on a regular seasonal calendar regarding the monsoon season, river flow rates, evaporation and transpiration patterns as well as reoccurring drought periods. Crop patterns, livestock and fish breeding were adapted to the regular climate events. Changing rainfall pattern, irregular monsoons and extreme weather events have been experienced commonly in the last decades and have led to new challenges to effective water management. Many phenomena are being linked to rising sea levels and increasing temperature although immediate impacts of climate change usually relates to extreme weather events and changes in rainfall patterns.

Current studies on changing climate tendencies in general predict an increase in extreme weather events. In a comparison of 1970 to 2030 the rainfalls in the rainy season are expected to increase by up to 4%, in the same time, the precipitation in the winter months is expected to further decrease. This is an existing development which is already being measured with recent data (7). The changed rainfall pattern leads to more floods and longer drought periods.

By 2050 a mean temperature increase of 2°C to 5°C is expected in India (8). Rising temperature in general will lead to an intensification of the water cycle. This could lead to further variability in rainfall pattern thus affecting the river flows. (9) Increasing air temperature is prone to manifest in higher evapotranspiration, whilst sea level rise can lead to further intrusion of saline water into the fresh water aquifers as well push backwater further into estuaries.

These changes make an efficient water management more urgent than in the past in order to climate proof water infrastructure and maintain sufficient and safe resources for the dry season.

SALINIZATION PROBLEM

Salinity of groundwater has become a common phenomenon in coastal regions. Water scarcity has led to intense groundwater pumping and over-extraction of groundwater resulting in seawater intrusion into the aquifer often many kilometres inside the country. Coastal salinity problems have been observed in a number of places in most of the coastal states of the country (1).

In regions along the coast of the Bay of West Bengal groundwater sources have been observed to turn saline in the dry season in the last few years. This phenomenon can be observed at various places where agricultural use of groundwater is common. A common approach is to install expensive desalination plants thus providing a short term relief to the local population. The cause for the occurrence of salinity is though not addressed.

Due to climate change the rainfall pattern has changed in the last years leading to longer drought periods. Strong uninterrupted rains have less time to infiltrate and run off into the oceans, thus the groundwater recharge is reduced. Aquifers near the coast generally have a lens of freshwater in shallow depths and denser seawater beneath the freshwater at deeper levels. In the case of extraction of groundwater resulting in decreased groundwater level beneath the level of seawater, saline water penetrates the aquifer diffusing in from the ocean. This leads to contamination of potable freshwater supplies. Many coastal aquifers have problems with saltwater intrusion as a result of decreasing groundwater recharge and intense groundwater extraction, leading to over extraction.

For areas with groundwater salinity, common solution approaches for the provision of drinking water are desalination plants. They provide a direct quick relief. The Actual cause of salinity is though not addressed. Although being technologically manageable as long as project funds are available, many desalination plants stop working as soon as the supporting project ends. Maintenance has to be done by the supplier and the local community seldom has the capacities to repair the plant. Operations and maintenance aspect are often neither integrated into the budgetary structure nor during the implementation activities of such projects.

Desalination plants further emphasizes the actual groundwater contamination. Main reason for salinity in the coastal region is the over extraction of groundwater and thus seepage of saline sea water into the fresh water aquifer. In a natural water cycle the higher level of the fresh water aquifer has enough pressure to prevent the saline water to intrude into the land. Pumping of fresh water from a coastal aquifer reduces fresh water level thus increases the water pressure so saltwater intrusion can proceed towards inland, reaching the pumping well. In the past years more and more tube wells have thus turned saline, especially in the dry season.

The presented case study thus focusses on the surface water usage. By enabling groundwater recharge at coastal aquifers further salinity intrusion is being prevented. Reintroducing surface water usage for human consumption also implies taking a special care of typical surface water contaminants related to serious diseases e.g. diarrhoea, hepatitis, typhoid fever and cholera. Thus awareness on quality maintenance and sound technologies for the treatment are prerequisites for a successful usage.

STRENGTHENING ADAPTATION CAPACITIES OF COASTAL COMMUNITIES

In the framework of climate change adaptation project activities, GIZ (Deutsche Gesellschaft für International Zusammenarbeit (GIZ) GmbH is conducting various small scale pilot activities which are related to IWRM under the Europe Aid funded project "Strengthening Adaptation Capacities of Coastal Communities (AdaptCap)". The activities are carried out together with the partners adelphi research, local governments for sustainability South Asia (ICLEI SA), Academy of Ghandian Studies (AGS) and Avvai Village Welfare Society (AVWS) and various local partner NGOs.

The project aims at empowering the local population and authorities by enhancing the capacities to respond to the challenges posed by changing climatic situation. The AdaptCap project will achieve its specific objective by a set of integrated activities carried out in 6 urban centres of AP and TN, and 3 surrounding villages of each urban centre. The project will allow for the development of an integrated approach for Climate Change planning by strengthening the urban-rural linkages. The project also enhances community's resilience by implementing pilot projects that addresses the climate change impacts and also developed local adaptation and mitigation strategy/ guide (LAMG).

Pilots which are related to the water management can be implemented by the communities themselves in many cases. The community is involved in the planning stage, implementation as well as O&M plan for the sustainability of the pilot measures. The community nominates or suggests a monitoring structure like a village development committee with members from SHG, youth group, community members, women SHG, CBO member etc. who will support the implementation of the pilot, in each community.

Farmers are involved in renovating and deepening irrigation ponds contributing to additional capacity and increased quality of surface water reservoirs. Plantations around the ponds avoid erosion and mudslides during heavy rainfall and provide a new livelihood. Maintenance of in- and outlets allow for drainage and effective water management. Fencing of reservoirs helps protecting the water quality from contamination by livestock involving pastoralists while benefits can be gained for provision of clean water for the livestock.

Drinking water scarcity and quality issues can often only be addressed by applying treatment technologies which require external suppliers and skilled labour. Water treatment suppliers often offer solutions which create a future market for the suppliers of filter media, chemicals, spare parts and maintenance service. Facing this challenge the AdaptCap project aims at elaborating treatment solutions which are developed in a participatory manner by involving community in decision making at various levels for creating an ownership and enhancing sustainability of the pilots in the long run.

PARTICIPATORY APPROACH

The locally affected population, especially women and the marginalized are involved in planning and implementation of the technological, logistical and financial management of the water resources. The technological infrastructure setup uses local conventional state of the art technology. This leads to sovereign decisions on the most appropriate model of water management.

The elaborated implementation plan focusses on demand driven solutions that meet the hydrogeological preconditions and socio-economic circumstances. Solutions are technologically feasible and based on the local technology transfer options. The approach aims at setting the frame for large scale implementation of this technology by designing and constructing pilot schemes and supporting the whole process by documentation of the technical as well as social and economic feasibility.

Participatory needs assessment workshops, focussing on the recent requirements regarding water demand as well as technical and organisational setup are conducted based on the prior collected information and experiences in the communities. In depth interviews are conducted with community representatives by involving Gram Sabhas and Panchayats (village administration), as well as with state district bodies of relevant state departments.

VULNERABILITY AND NEEDS ASSESSMENT

In the AdaptCap project, participatory Vulnerability and Needs Assessments (VNA) have been conducted in 18 communities in 6 clusters in Andhra Pradesh and Tamil Nadu. The results show that 15 communities were having problems with the water quality. Quality issues were mainly related to salinity of groundwater sources as well as bacteriological contamination of surface water sources. Further 13 communities were suffering water scarcity. All assessed communities claimed to have occupational and health problems.

As bottom up solution from the communities, more than 19 measures were suggested related to an improved water resource management and 18 measures related to water treatment and purification systems. 12 measures were related to waste water management and 8 measures to water extraction, storage and supply. Also measures related to improved demand side water management were suggested by the communities.

The most common climate change adaptation measure that was suggested by communities was the construction and/or strengthening of coastal belts and sea bunds (9 communities). The second most common measure was the installation of surface water treatment systems (8 communities). Construction, renovation, desilting of storm water drains and sewage systems as well as renovation of ponds tanks and surface water reservoirs were suggested in 7 communities each. Improved rainwater harvesting and general water treatment and purification systems were suggested in 6 and 4 communities respectively.

The overall impression of the VNA regarding IWRM was that a high awareness for improved management of surface water sources and the usage of surface water sources substituting saline groundwater was present. This in depth understanding of the local water cycle by the communities showed that a solution with respect to water resource management focussing on improvement of the availability and quality of surface water is a promising approach. Being the prior demands of the local population, ownership and future maintenance are probable thus providing good chances for sustainable long term solutions.

CAPACITY DEVELOPMENT

The training needs assessments in the VNA formed the basis for the detailing out of the capacity development. In further participatory workshops the training and workshop contents was decided on. The general approach of the capacity development is the multiplicative Training of Trainers (ToT) model so that local trainers can continuously keep up the competency level of the population and reach out to a larger population. The workshops for the direct beneficiaries to facilitate involvement into all project steps are held in cooperation with the locally educated trainers. Workshop contents cover the development of a water resource management on the community level and organisational development for the water commission. At later stages specific planning, implementation, operation and maintenance as well as monitoring, evaluation and business management workshops for the pilot initiatives are introduced to support the local water commissions. Each training or workshop is evaluated and the results are incorporated in the future setups of the upcoming sessions.

LINKING COMMUNITY SUGGESTIONS TO CLIMATE CHANGE IMPACTS

For crosschecking the suggested measures from the VNA with the assessed impacts and their further prioritization a matrix was developed including linkages between CCA measures and CC impacts being addressed by these measures. With the help of this matrix and further workshops in the communities finally three pilot activities were decided on by each village which would be considered to be taken up. In a final evaluation procedure taking into the following criteria a pilot for each village is decided on:

<u>Criteria for evaluation of pilots:</u>

• Risk reduction: How effective does the adaptation pilot project reduce a climate risk?

• Acceptance: Is the pilot project culturally appropriate and supported by the community? (e.g. religious, social, political etc.), Are all necessary official approvals documented? Is it compatible with the actual local / indigenous practice, e.g. with past coping activities or adaptation measures?

• Feasibility: Is the measure technically viable? Do experiences with the technology exist in the area?

• Cost: Is it economically viable to implement? Is it economically viable to operate and maintain?

• Side effects, benefits and negative impacts: Helps the most vulnerable? Addresses gender issues? Addresses children? Addresses elderly? Contributes to social, environmental and economic development? How flexible/reversible is the pilot? Is the impact positive regardless of future CC? (no regret pilot) Does the project have negative side effects?

Pilots requiring technical input from external suppliers were further supported by the project team. One of these pilots was the up gradation of the water supply scheme in a cluster of villages in the coastal belt of Vishakapatnam where the villagers were suffering from access to safe drinking water.

CASE STUDY: SCARCITY OF DRINKING WATER IN COASTAL VILLAGES

The two villages Chepaladibbadialem and Chukivanipalem are neighbours and have similarly affected by climate change. They are situated half a kilometre from the coast in the Chepala Uppada Panchayat, Bhemmunipatnam Mandal, Visakhapatnam District in Andhra Pradesh.

The population of the villages is 488 and 324 respectively having 126 and 80 houses. The main livelihoods are fishing and assistance in fishing as well as fish export to Visakhapatnam. Due to decrease in fish catch 26 and 5 families have migrated in search of work. In the last years 12 and 5 SHGs have been setup and fish drying business has been taken up. Very few families are involved in farming activities. NGOs have been supporting the villages in setting up sanitation facilities and vocational training.

In various needs assessment workshops and participatory trainings the topics of climate change and their current and future impacts were worked out with the villagers. In the ranking of the current and potential future impacts on their livelihoods the communities have prioritized the impacts in the following order:

1. scarcity of drinking water
2. salinization of ground water

3. decrease in fish catch
4. loss of crop / stock / migration to other working areas and places
5. damage to land

Among around 30 activity suggestions made by the villagers those related to the first two priorities were:

- Improve drinking water supply network
- Construct ground level storage water tank
- Improve rain water harvesting
- Water reservoir quality conservation systems
- Promote judicious use of water implement technical less water consuming practices
- Improve / renovate pumping system (to reduce leakage)
- Introduce water budgeting practices
- Strengthening of traditional water resource systems and practices
- Water treatment / purification systems
- Improve / renovate sewage system / desilt drainage channels
- Construct / renovate / desilt storm water drains / flood water diversion channels
- Drilling / deepening of well
- Improve waste management / set up solid waste management system

In the next round of workshops with technical experts visiting the region and working out adaptation options both village communities agreed on jointly tackling their prior need: safe drinking water.

SETUP OF WATER COMMISSION

As a result of the workshops a water commission was setup to assess the exact problems and work out detailed action plans on the basis of the jointly defined objectives. The commission has the aim to coordinate between the external experts providing support and the representatives of the local population providing information. As one of the first tasks information related to the situation of the water supply was assessed and water tests for selected sample points were conducted.

The groundwater below 20ft in the village is mainly saline, thus only one shallow temple well provides fresh water. In longer dry seasons the groundwater levels drops significantly and shallow fresh water becomes scarce or even unavailable. The main source of fresh water is the piped water supply being constructed by the rural drinking water department and maintained by the Panchayat. This supply scheme pumps the water from an infiltration well in the Gambheeram Gadda River to overhead tanks and supplies to villagers through distribution pipelines. However, the villagers noticed turbidity in the water and stopped using it for drinking. Local NGOs report that many villagers were hospitalized from this contamination mainly during monsoon periods. The villagers have chosen instead to drink the water from the traditional shallow dug well near the village temple, which though does not suffice for the overall needs of the communities.

The Chepala Uppada water supply scheme for Chepaladibadapalem and Chukkavanipalem covers another 5 villages with a total population of 3687 who would also be benefitting from this pilot activity. Considering 40LPCD, a population growth and an additional buffer an approximate supply amount of 200 KLD was aimed at. The infiltration well is placed 1.3 km from the overhead tank (OHT) which has a capacity of 200 KL. The well has a diameter of 6 meter and a depth of 3.5 meters. The water is extracted with a 7.5 HP pump which is connected to a 24 hour electricity supply. The infiltration well is surrounded by pebbles and sand patches. The pebbles could indicate that the water infiltrates at a quick rate possibly not being filtered sufficiently. The piped water supply distribution network stretches over an area of 1.5 by 2.5 km with a total no of 45 tap points. Bacteriological measurements from the end of the distribution network have shown higher contaminations than closer to the OHT thus indicating possible contaminations in the distribution network.

Considering various options it was decided to upgrade the existing piped water supply scheme by installing a suitable treatment and analysing the distribution network for possible leaks and contaminations as well as assessing the catchment area for possible pollutants and working out protection measures.

CATCHMENT AREA OF THE SUPPLY SCHEME

Chepala Uppada lies in the river basin of the East flowing rivers between Mahanadi and Godavari. The main source for supply scheme is an infiltration well placed in a perennial river called Gostani River or Gambheeram Gadda after the name of the so called reservoir from which the river is mainly fed. Other sources of the river are reservoir near to Bakkannapalem on the road to Sontyam and several tributaries mainly sourcing from the Simhachalan Range. Both reservoirs also have their main catchment area in the Simhachalan Range (Eastern Ghats).

Additional water sources are various ponds and lakes in the vicinity of Chepala Uppada, the biggest lake is Khambala Cheruvu. Further surface water bodies in Sai Sagar Nagar have recently been renovated and have considerable capacities to provide water.

The precipitation in this area is around 1200 to 1500mm per year concentrated in the periods of the southwest monsoon from June to September (around 75 % of the rainfall) and the northeast monsoon from December to February (around 20%) of the rainfall). In the last years a decreased intensity of the winter monsoon was observed. In 2011/2012 there was almost no rainfall and thus the reservoirs were not filled with water.

First assessment in the catchment are related to the water quality for the infiltration well have been conducted. The two reservoirs indicate to be free of man-made contamination as they are sourced by the Simhachalan range, which is a hilly and rocky area covered with trees and shrubs and very little population. The tributary from the Bakkannapalem reservoir though flows through a residential area where currently housing constructions are being taken up and has inflow of sewage around 8 to 10 km upstream of the infiltration well. In Gambhiram effluents from a fish processing unit are discharged into the Gostani river around 5km upstream from the infiltration well.

Water samples at the intake point of the infiltration well have shown satisfactory results for the chemical analysis. In some of the samples though bacteriological contamination was found. It was further explained by the local operators of the supply scheme that the water has visible turbidity during monsoon periods.

POSSIBLE PROTECTION MEASURES IN THE CATCHMENT AREA

The Gambheeram Gadda River and its tributaries flow through various habitations and an area with industrial activity. The point sources and the quantities and quality of sewage and effluent discharge are to be identified and possible treatment options are to be worked out with the polluters. For domestic sewage diversion into wetlands could be considered which could then be connected to the river after having purified the sewage to a reasonable level. Workshops with the industrialists on possibilities of effluent treatment or recycling of chemicals and salts in the effluents can lead to reduction of effluent loads. If treatment options are not viable possible diversions of the effluents from the rivers to drainage channels are to be considered.

Workshop with farmers for the awareness creation on the usage of fertilizers and possibilities of organic farming can be held. In case of necessity of intense agriculture bunds along the fields for diverting runoff into the river can be considered.

Special attendance is to be given to the activities on the river banks up to 1km upstream of the infiltration well. Here preferably least impact on the water body is to be maintained. If possible a 20-50m radius around the infiltration well should be fenced to protect the water resource from human and animal defecation, accumulation of garbage and other possible contaminations.

As a last option in case of non-cooperation of water pollutants water quality is to be compared with the effluent discharge standards of the Pollution Control Board and notice with request of verifying compliance of the polluting unit might have to be considered. This option should be well discussed with all stakeholders prior as it might cause a possibly unnecessary confrontation which would lead to further problems in the shared usage of the common resource.

TREATMENT AND PURIFICATION FOR POTABLE USAGE

The first treatment options discussed at the village level were the installation of a reverse osmosis (RO) plant. Advantages were seen in secured water quality and treatment of salinity. The local NGO, external experts together with the water commission discussed various options. It was discussed that the and RO plant for treating 200KLD would be very expensive in installation costs as well as in maintenance costs, if the solution would be RO the quantity of water which could be treated would have to be only a small part and it could also not be distributed through the existing piped water supply network. Villagers would have to come to one central place to collect their drinking water. Another point of discussion were the maintenance costs, these would consist of regular consumption of anti-scaling agent, exchange of micro filters, exchange of RO modules as well other spare parts and considerable power consumption. The water would have to be sold at a rate of around 5 INR per 20L bottle. Additionally 50 -75% of the water would be lost as waste water from the washing process of the RO modules. Thus for achieving a 200KLD supply quantity 400 to 500 KLD would have to be provided by the extraction well.

On the other hand the water from the infiltration well was not saline and also did not have elevated levels of dissolved solids which would require an RO treatment. Basically only suspended particles and bacteriological contamination would have to be removed. For this treatment various other simpler technologies were available like roughing filters and slow sand filters which were quoted to cost only one third of the investment and only labour and plumbing maintenance work. In former project proposals for this supply scheme treatment with micro filters had also been suggested.

The treatment options presented here follows the principles of the most viable technology which can be setup and maintained by the local community without being dependent on external suppliers. The basic process does not require any energy apart of pumping the water into the filter as the system runs on gravity. The system is designed in a way that it can be upgraded if energy sources are available and the quality can further be improved by a modular attachment of more treatment steps. The primary goal of the described technological approach is to treat the water to the permissible limit of the Indian drinking water quality standards. Taking into consideration these criteria the process consists of roughing filters and slow sand filters. According to layout and performance disinfection might be necessary.

The primary filtration is being taken care of by a horizontal roughing filter (HRF). The HRF is an efficient pre-treatment step for slow sand filters increasing the lifetime of the slow sand filter significantly reducing turbidity of the raw water. Typically three filter beds are passed. The first filter bed having a gravel size of 10-15 mm, the second having a gravel size of 5-10 mm and the last bed having a gravel size of 1-5 mm. The flow rate is normally between 0.5-1.5 m/h. This type of HRF can reduce particulate matter by 90% or more and improve the bacteriological water quality by 1-2 log reduction of faecal coli form. To limit the filter head loss regular filter cleaning is necessary. For this purpose drainage are constructed at the bottom of each bed which allow the accumulated solids to be flushed out. (16)

According to the performance of the filter this water can thus already be used for certain usages like bathing or washing. For achieving drinking water quality the HRF has to be followed by another treatment step. We look into the option of setting up a slow sand filter. Slow sand filters (SSF) function by forming a film of bacteria and algae on the surface of the sand as the water passes through it. The rate of flow should be controlled to 2.5 m per day, or a vertical flow rate of 0.1 m/h, and the filter must be cleaned periodically as the flow rate drops, by removing a skin of sand (2cm). Two parallel units are installed, so that supply can be maintained when one unit is out of work due to cleaning.

Assuming a surface water quality of Suspended Solids (SS) of 9 – 120 mg/l and Turbidity in the maximum range of 20 – 220 NTU the multi stage filter (MSF) of HRF and PSF/SSF achieves an average SS removal as well as Turbidity removal of 95%. Assuming Total coliform in the raw water to be in the maximum range of 1200 – 1600 and Faecal Coli in the range of 1000 – 1600 per 100ml the MSF achieves a removal of up to 9 Total coliform and 4 faecal coliform per 100ml in average. (16) Thus according to the performance post disinfection might be necessary. Disinfection of water can be accomplished via a chlorination process. Chlorine is added to the water thereby eliminating pathogens present in the water.

OPERATION AND MAINTENANCE OF DISTRIBUTION NETWORK

One major source of contamination is the distribution network. Water can be of impeccable quality at the point of treatment or the OHT, if the distribution network is not maintained properly the user might receive polluted water. In cases of a 24/7 pressure distribution leakages only lead to the loss of water. In intermediate supplies as in the case of the Chepala Uppada water supply scheme and most other rural water supply schemes in India, contaminations enter into the distribution network when the pressure inside the network drops and the leaked water enters back into the pipe together with any contaminations mixed to it, possibly sewage from drains if the pipes are located near to the sewerage. For reducing risks of contamination with sewage the distribution networks should thus always be laid above the sewerage so that the sewage does not intrude the drinking water supply by gravity. As the bacteriological quality results were worse at the tap points at the end of the distribution network the distribution network would have to be checked for leaks and possibly relocated in cases where it is located near to the sewerage.

Apart from the quality issue one major reason for the scarcity of water availability is also the poor maintenance of the taps. Taps have to be checked for proper closing and have to be replaced in cases where they are missing on defunct. Workshops for awareness creation for proper usage of the supply scheme and reduction in wastage of water by maintenance of tap points can be considered.

MONITORING OF OPERATION AND ADMINISTRATION OF SUPPLY SCHEME

The organisation and technical operation of the overall IWRM including all the installed infrastructure has to be monitored continuously. Especially regular monitoring of the water quality of the water source, the treatment system and at the point of end user consumption has to be taken care of. All parameters of the IS10500 have to be monitored. In cases of budget stringency indicator parameters can be monitored during normal operation. For the infiltration well source indicator parameters could include: Turbidity, Total Dissolved Solids, Microorganisms, Alkalinity and pH. Indicator monitoring for the water storage as well as the tap points can be only Turbidity, Colour, Taste and Microorganisms e.g. coliform bacteria. Monitoring of the indicator parameters should be conducted at least monthly for the source and weekly for the storage tank and distribution network. In case of any complain from a user monitoring of all parameters should be conducted asap.

The water commission has to maintain a sound documentation and document any disturbance and failure so that direct appropriate action can be taken (18). In case the funds available with the Panchayat for the monitoring, operation and maintenance of the supply scheme should not suffice, fees would have to be collected from the users in order to pay the field staff of the water commission for monitoring and reporting on the catchment area management, the technical staff for the operation, backwashing, scrapping and replacement of sand of the treatment plant and the monitoring and maintenance of the distribution network.

The sustainable financial concept as a prerequisite for the long term solution has to be constantly observed and necessary amendments implemented. Preferably enough funds are provided by the central or state government so that user fees do not have to be levied. Minimal socially structured user fees though also create awareness and a feeling of ownership of the water supply scheme and contribute to its proper usage and maintenance.

FURTHER OUTLOOK AND UPCOMING ACTIVITIES

In the upcoming months the work of the water commission will be essential in finalising the climate adaptation measure. In the current phase of the project, protection measures are discussed with the polluters in the catchment area. The details of the treatment process are being worked out by the local NGOs and the water commission supported by technical experts. The maintenance of the distribution network is being conducted together with the Panchayat Construction works are planned to start in April.

The project will evaluate the implementation of this pilot and then further disseminate results and best practices. Integration of climate change activities into government programmes and replication of best practices are being looked into as next step. E.g. Watershed development and Catchment area protection measures can be linked to the Mahatma Gandhi National Rural Employment Guarantee Scheme. Specific state initiatives focussing on IWRM would produce further major impact. Positive examples in the past were initiatives like the Neeru Meeru (Water and You) programme which had started in 2000 and in its first three years of implementation had created additional water storage capacity of more than 18000 lakh m^3 by water harvesting structures like percolation tanks, dugout ponds, check dams, etc.. (2)

CONCLUSION

The success and viability of the presented approach is based on an extensive vulnerability and needs assessment (VNA) in which all sectors have participated. The VNA has been conducted considering the specific social, cultural, ecological and financial background of the concerned communities. For a technical sustainable solution IWRM has to consider present and future climate changes related to changing rainfall patterns, droughts, groundwater depletion and quality deterioration, sea level rise as well as heat waves and extreme weather events. In coastal areas the decreasing groundwater recharge together with the increasing groundwater extraction has led to the phenomenon of salinization of aquifers. A long term approach is the improved management of surface waters providing greater quantities of water resources for various usages. Groundwater extraction are thus be substituted on the one hand, on the other hand increased groundwater recharge is achieved. This leads to desalinisation of the aquifer and existing smaller extractions of groundwater for drinking purposes can be continued on mid-term. With the introduction of catchment area protection and pollution minimisation in the river basin the quality of the surface water sources can be improved. Having improved its quality the surface water can be treated by locally implementable and maintainable technologies to drinking water standard. Thus the community does not need to use expensive high tech treatment technologies for desalination. The process is conducted in a participatory approach involving local capacities in planning, implementation, operation, monitoring and maintenance. Community ownership of the infrastructure further contributes to a sustainable overall concept. Experience exchange, comments and discussions on the topic of climate change adaptation and water resource management is welcome at any stage of the project. Please contact the author in this regard:

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BRIEF PROFILE OF THE AUTHORS

Ronjon Chakrabarti graduated in Environmental Engineering from the Technical University of Berlin in 2007. During his graduation he worked as lecturer on critical environmental protection and information technology from 2002 to 2006. Since 2006 he is working for adelphi in the fields of climate change adaptation, integrated water resource management and water quality control as technical expert and project manager. He is currently pursuing his Ph.D. in Environmental Engineering with a focus on rural water supply based on surface water at the TU-Berlin and Jadavpur University of Kolkata.

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