Institute Registration Number	Institute Name	Theme(s)
1001148	Rishi Valley School	Water

WATER AND THE VALLEY

The state of water availability in India is rapidly deteriorating with only 30% of Indians having access to clean, potable water. A study carried out in 2009 indicated that total water demand in India is projected to increase by 89% during the period 1997 to 2050 with an estimated decrease in per capita availability of ~44% during the same period[1]. Water availability and the reasons for its shortage are very different in the rural and urban areas of India. In this paper we would like to assess the water situation in a particular region, namely, Rishi Valley, Andhra Pradesh. We will address the problem by analysing the water situation in the valley 15 to 20 years ago and compare it to the current situation to come up with patterns that can be used to improve the deficiencies in our water system. We also wish to suggest some innovative solutions to address the problem.

Rishi Valley School has a campus of 350 acres and a population of about 500 that live on the campus. The valley has a largely rural population and lies in a rain shadow region with no major river flowing nearby, resulting in dire water shortage. These two factors result in the community having to deal with the resource more mindfully. Recently, the AP government has given the status of a 'Special Development Area' to the entire valley, which includes the school and neighbouring villages. Both the school as well as the 'Special Development Area' have taken the issue of water conservation and recycling very seriously. Despite the initiatives taken on campus, there is still a lot of pressure on the water table with 5 borewells drying up in 3 years.

Our aim is to study the initiatives/practices of conserving, managing and reusing water from the recent past (15-20 years). A unique data source that we have access to is the statistics on water usage that have been compiled by students of Rishi Valley School in the last 5 years, as part of the school curriculum. We will also conduct interviews with staff members as well as people from the local communities to get a broader perspective on the problem. We hope to make note of the patterns or trends through the past years and come up with informed solutions that will be applicable to the current situation. We also plan to study the attitudes of people in the valley to water use and determine whether there is a correlation between water availability and the drive to conserve it. Finally, we believe that our analysis of Rishi Valley's water problem and the proposed solutions could serve as a model for other communities of similar size across India.

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1.0 Rishi Valley : The Community

Rishi Valley is located in Kurabalakota Mandal of Chittoor District, in Andhra Pradesh State , about 160 km northeast of Bengaluru (Figure 1 shows the geographical location of Rishi Valley).

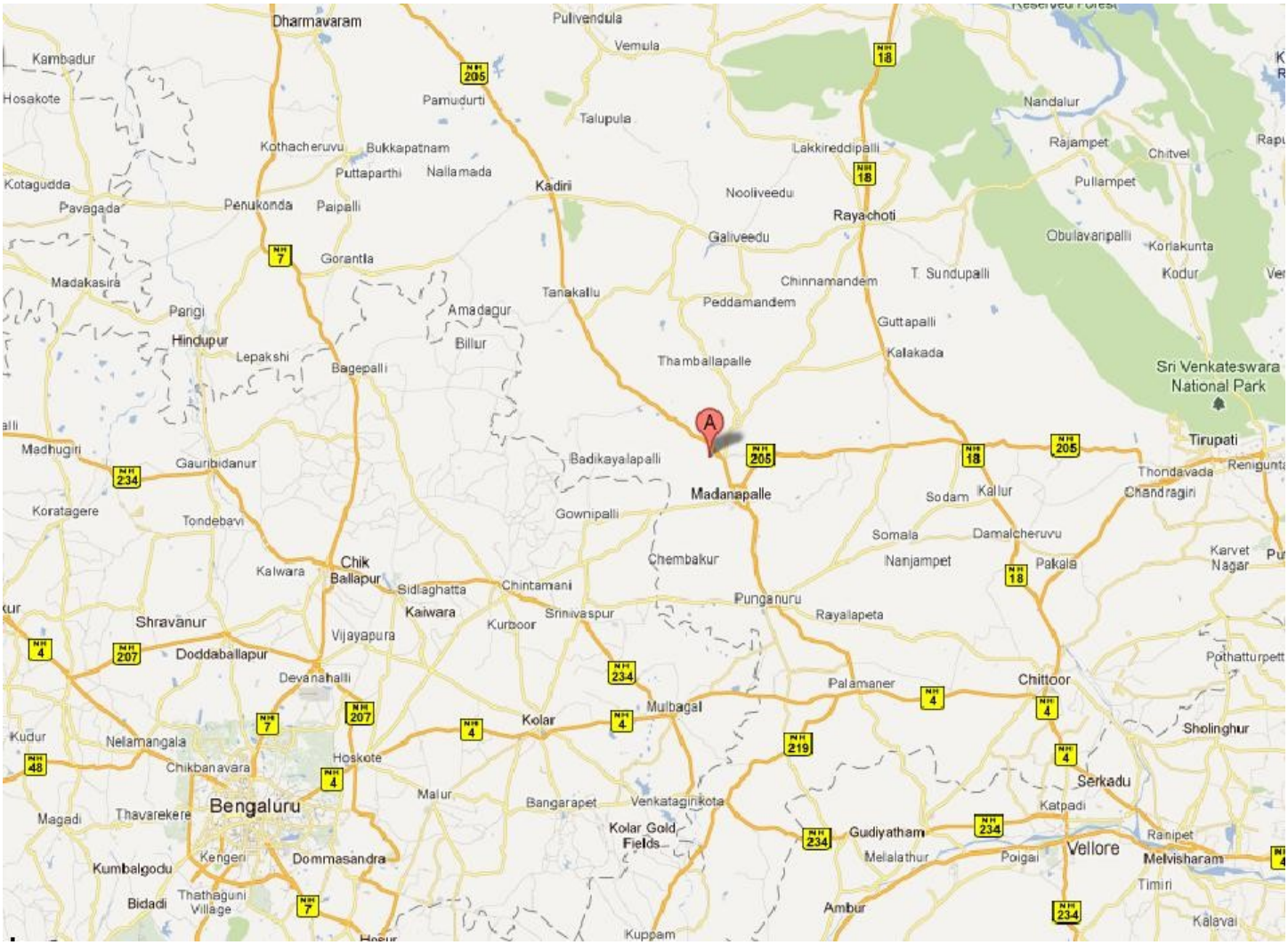

Figure 1 – Geographical location of Rishi Valley, marked as A on the map. Bengaluru is 160 km southwest of Rishi Valley.

The Rishi Valley Education Centre(RVEC) established in 1931 by the renowned philosopher, J. Krishnamurthi, is located in this resource fragile environment. Over the last 80 years RVEC has dedicated itself to the preservation and conservation of nature in the Valley. Conservation has become part of both the theory and practice of the school.

With the prospect of conserving the ecosystem in Rishi Valley as well as its spiritual legacy, the Government of Andhra Pradesh declared Rishi Valley and its surroundings a 'Special Development Area' (RVSDA) in January 2008. The extent of the RVSDA is 33 villages in Thettu and Kurabalakota Panchayats of the Kurabalakota Mandal covering an area of about 5176.97 acres[2]. The RVEC and the Andhra Pradesh Government have carried out pioneering efforts to conserve natural resources and manage water better in the Valley.

Rishi Valley is situated in a drought-prone area with agriculture and livestock being the main

sources of livelihood for the community. Groundwater serves as the primary source of water for agriculture, livestock and domestic use (drinking, washing, bathing, cooking etc.). In 1980, the Government of Andhra Pradesh delineated a 150 acre hillock to the RVEC for the purpose of afforestation[2]. This land has been successfully wooded since, through efforts at re-vegetation by the students of RVEC and construction of percolation tanks and check dams to ensure soil and moisture conservation.

RVEC has a population of approximately 350 students and 300 staff. Water is used on campus for drinking, washing and bathing, growing vegetables using agroecological practices in a 16 acre vegetable garden, growing millets, bananas, sugarcane, turmeric, jamun and sapota on the 150 acre farm as well as maintaining a dairy to supply the dining hall where meals are prepared for the campus residents. Water and the stress on depleting water resources is therefore the main issue of concern for the school.

2.0 Recent History of Water in the Valley

Historically, in the Valley, water was extracted through dug and open wells till the late 1970s. A survey by the Groundwater Department of Andhra Pradesh in 1970-71 reported water levels of about 30 – 50 feet below ground level [3]. With the advent of borewells in the 1980s, water levels started receeding and today the levels are anywhere from 500-800 feet below ground level. Interviews with teachers and staff who have been at Rishi Valley School since the 1980s indicate that water was a scarce resource even then and the school had started measures to conserve it [4].

It appears that the water situation grew increasingly worse over the years, as indicated by the 2006-2007 survey of the Groundwater Department that showed a total of 203 borewells in the area, of which 150 had dried up due to seasonal conditions[5]. Since 1996-1997 there has been a sevenfold increase in the number of borewells which has lead to increasing stress on the water table. Some conservation measures were bearing fruit such as the existence of 52 checkdams and 36 percolation tanks ensuring that there was practically no run-off water in the area [6].

3.0 Situation Analysis of Water Resources in the Valley

Rishi Valley receives both the southwest and northeast monsoons. The temperature varies form 8 C to 39 C and the humidity in the valley ranges from 30% RH to 85% RH.The average rainfall in the area is approximately 700 mm with the annual rainfall attaining an all-time high of 1200 mm in the year 2005. Since the area falls in a rainshadow region, the rainfall is erratic and unpredictable. Historical records suggest that droughts are a regular feature in the region, with the last major drought in the 1980s when the water table fell below 200 ft[5].

The average annual rainfall in Rishi Valley in the last ten years is nearly 880 mm, with an all time high of 1170 mm in 2005-06, and a significantly low total of 460 mm in 2003 [7]. According to local meteorological data, most of Andhra Pradesh, especially coastal areas, experience an average annual rainfall of 850 mm while the long-term average of Rishi Valley is 750 mm, and the short-term is 550 mm[7]. This illustrates the vast difference in rainfall of our land and our surroundings. The trend in annual rainfall over the last thirteen years is shown in Figure 2.

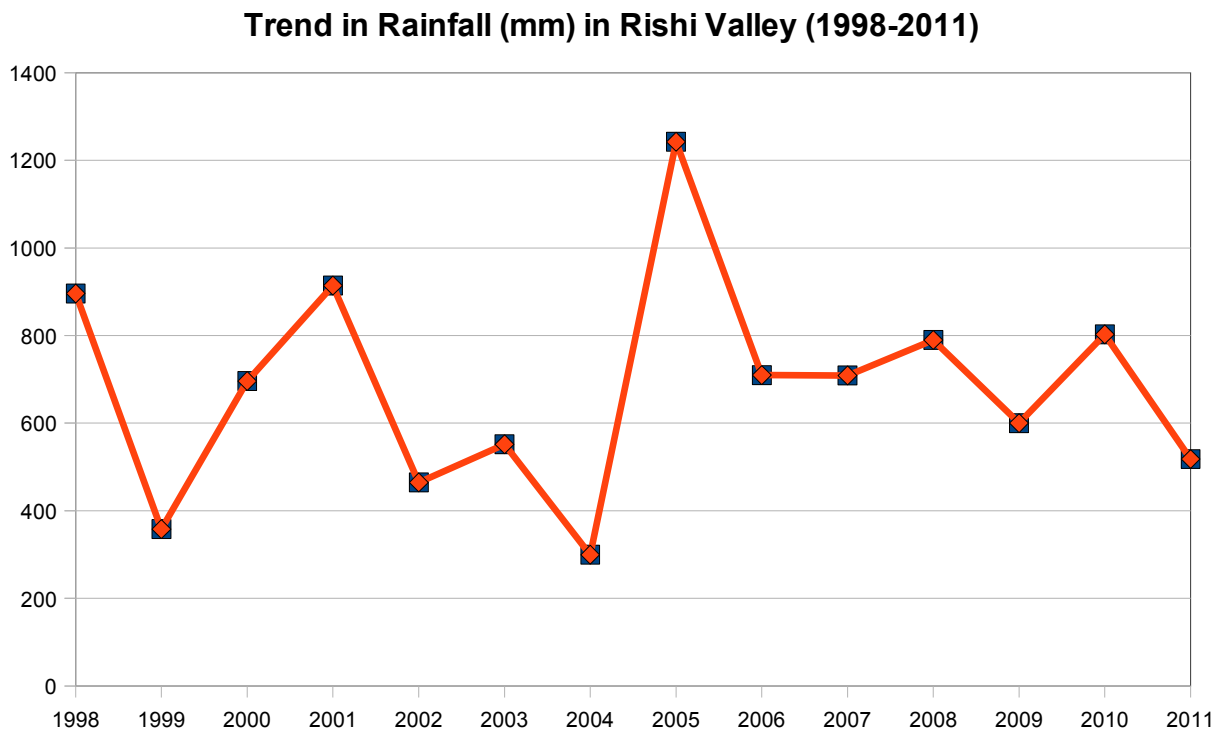

Figure 2 – Annual Rainfall in Rishi Valley (1998-2011).

As noted above the water needs of the campus are varied and extensive. Over the years the RVEC has put energy into developing a sustainable community and this has led to the growth of the farm (called 'The Estate'), the organic vegetable garden and the dairy. Therefore apart from human needs, there are also significant demands on water because of cultivation and livestock.

To determine the water outlay in RVEC we have relied on data collected by students over the past few years. Water usage and conservation measures has been a well studied subject on campus as part of Environmental Education projects. (Environmental Education is a compulsory subject across all classes). A summary of the data collected and averaged over 8 days from one study in 2009 is presented in Table 1.

Table 1 – Summary of Daily Water Extracted from the Aquifer on RVEC Campus, 2009

Consumer	Number of borewells	Amount Extracted (litres per day)
Rishi Valley Campus – 600 people	2	99225
Rishi Valley Estate	3	1,26,000
Rishi Valley Vegetable Garden	1	40000
Rishi Valley Dairy	1	36000
TOTAL	**7**	**3,01,225**

From the summary data, one can see that nearly one-third of the consolidated water consumption is that of the 600 people on the campus. Their water-consuming activites include bathing,

dishwashing, cooking, cleaning etc. The Estate, with the highest number of borewells, is 150 acres of farmland and uses the water only for cultivation. Although water intensive crops such as sugarcane and turmeric are grown to reduce our food miles, the cultivation methods used are water efficient. Sugarcane is grown using the Madagascar system of cultivation where spacing between the rows of the crop are increased to reduce water consumption by 50% . In addition, all the irrigation on the Estate is through drip irrigation which further increases water use efficiency**.** The Vegetable Garden, providing approximately 60% of fruits and vegetables to the School, uses drip irrigation nearly 200 days of the year to regulate use of water, but still consumes 40 kL of water a day to irrigate 16 acres. The Dairy uses 36 kL of water a day to provide milk to the RVEC campus from high-breed Holstein-Friesian cows. However, more recently due to some problems with the cattle, milk production has reduced.

Compared to urban communities, RVEC's water consumption and measures of water conservation seem to be fairly effective but because of the poor rainfall and acute water shortage, the measures are not adequate. While examining the consumption within the School (this includes all the hostels and staff members' houses), one notices the drastic differences in the water consumption within a few hostels and between staff members' households and hostels. Two of the hostels studied have the same number of residents but one consumes more than twice the amount of water than the other - 32 L per person per day in the first case and 69 L per person per day in the second case. A survey was also conducted on the water consumption of 31 different staff homes and it was found that two houses showed numbers as high as 220+ litres per person per day [8].

As discussed in Table 1, 100kL of water used by the School per day includes consumption in all hostels, residences, guest houses as well as the entire Dining Hall plus the laundry service and the hospital. In each location, one cannot cut down on consumption as every location requires a certain minimum amount of water. However, used water can be recycled to conserve water, as is being practiced on campus. This is discussed in greater detail later in the report.

Coming to water storage on the School Campus, there exists around 21 overhead tanks with a total storage capacity of 268 kL which meets about 2.7 days of water consumption by the School[8]. Usage and recharge happen simultaneously and there has never been a case of overhead storage tanks of water being completely depleted.

4.0 Awareness and Attitudes of People in the Valley

Due to lack of adequate conservation efforts in the usage of water in and around the RVEC campus, many of the remote villages in the Valley do not have clean and hygienic water for their daily consumption and usage. In many villages, the taps in the streets are left open, when water supply is released. Leaking taps are common and the general awareness regarding the need for water conservation is limited – this may be compounded by the fact that nobody on Campus and outside in the community pays for water!

We interviewed the Sarpanch of the Thettu Panchayat (to which RVEC belongs) and some local residents regarding water shortages and attitudes towards water. The interviews show that many people are not aware that they are living on the edge of their fast-depleting water supply. The rich farmers (ones who have more land) overexploit the groundwater through multiple borewells and cultivation of water intensive cash crops since they have a good market. The smaller, poorer farmres and labourers are aware of the crisis and are trying their level best to use water judiciously. According to some farmers, they try to fix leaking taps and close open taps, but this only addresses a small part of the problem [9].

In the past, before borewells entered the Valley, water was fairly well managed and shared among all farmers (large and small) through community-based management practices where people called *neergattis* allocated water to farmers for agriculture depending on the water levels in the storage tanks [10]. Crops grown were largely dryland crops which were drought-resistant and depended on rainfall or water from open wells / tanks. The animals were also local breeds which are much less water-intensive than the exotic breeds of cattle that are being maintained these days for milk production. As a result the stress on the groundwater was much less and people had adequate water for potable use and for their livelihoods.

On RVEC campus, students tried to spread awareness through different means. One example is by putting up posters near taps which were used on a regular basis and in excess which asked the users to be careful and reduce consumption of water where possible – mostly near bathrooms and toilets. This worked to some extent and when a follow up was done on attitudes, it appears that this was not enough and there needs to be serious action taken on the unnecessary usage and wastage of water [8].

5.0 Critical Analysis of Water Usage in the Valley

The water stress on the RVEC Campus is due to three main factors: (i) the geographical position of the Valley and its seasonally low rainfall. One can not alter this fact and this is one of the main reasons that the rain water constituting the input in our water cycle, is always a low number; (ii) poor infrastructure in the form of inefficient fixtures and water utilities around the Campus. A lot of water is lost in a casual way through faulty water meters, leaky taps, rusty / broken pipes or leaky tanks. Most often the maintenance staff are notified but students must take more responsibility in this context; and (iii) inadequate awareness among campus residents – students, staff and other residents. People should be more aware about the water situation on the campus and be more involved in its conservation. Awareness has grown over the years but still water is lost due to the carelessness of people e.g. leaving taps running or being careless while handling water in general.

A long-term issue is also the overexploitation of groundwater through innumerable borewells. As the data shows, drilling borewells maybe doing more harm than good as each time the we have to go deeper into the water table to extract water.

6.0 Innovative Measures for Water Management

For a problem as complex as water, there have to be solutions at all levels. In a community like Rishi Valley, that has been around for 80 years, people have identified the problem in the past and come up with solutions for improved water management. But with the change in water usage patterns due to changes in livelihood practices, increased exploitation of the groundwater and the increasing unpredictability of the rains, water has become **the most critical and stressed resource in the Valley.** As many of the staff and teachers have said in interviews Rishi Valley has to try and recycle all of its wastewater and see how the existing resources can be used more sustainably. Rishi Valley like any community has a water cycle. At each stage in the water cycle it is possible to implement water saving, reuse or better management as we would like to suggest and hopefuly implement.

Figure 3 shows the water cycle on the RVEC campus including the existing and proposed measures for more efficient water management.

Water Conservation at Source

The first stage in the water cycle is how we receive water. Rishi Valley has two main water sources, groundwater resources and rainfall. Rainwater can be a very efficient way of providing part of the water required for the community and thus reducing the stress on the groundwater resources. A major way of conserving rainwater and run-off is in the form of percolation tanks. Two large percolation tanks were created on campus in the period 1984-86 to collect rainwater and enable groundwater recharge. As discussed earlier, 52 check dams and 36 percolation tanks constructed across the Valley with assistance from RVEC has resulted in capture of as much rainwater as possible to recharge the groundwater [4]. As a result there is virtually no surface flow of water leaving the valley.

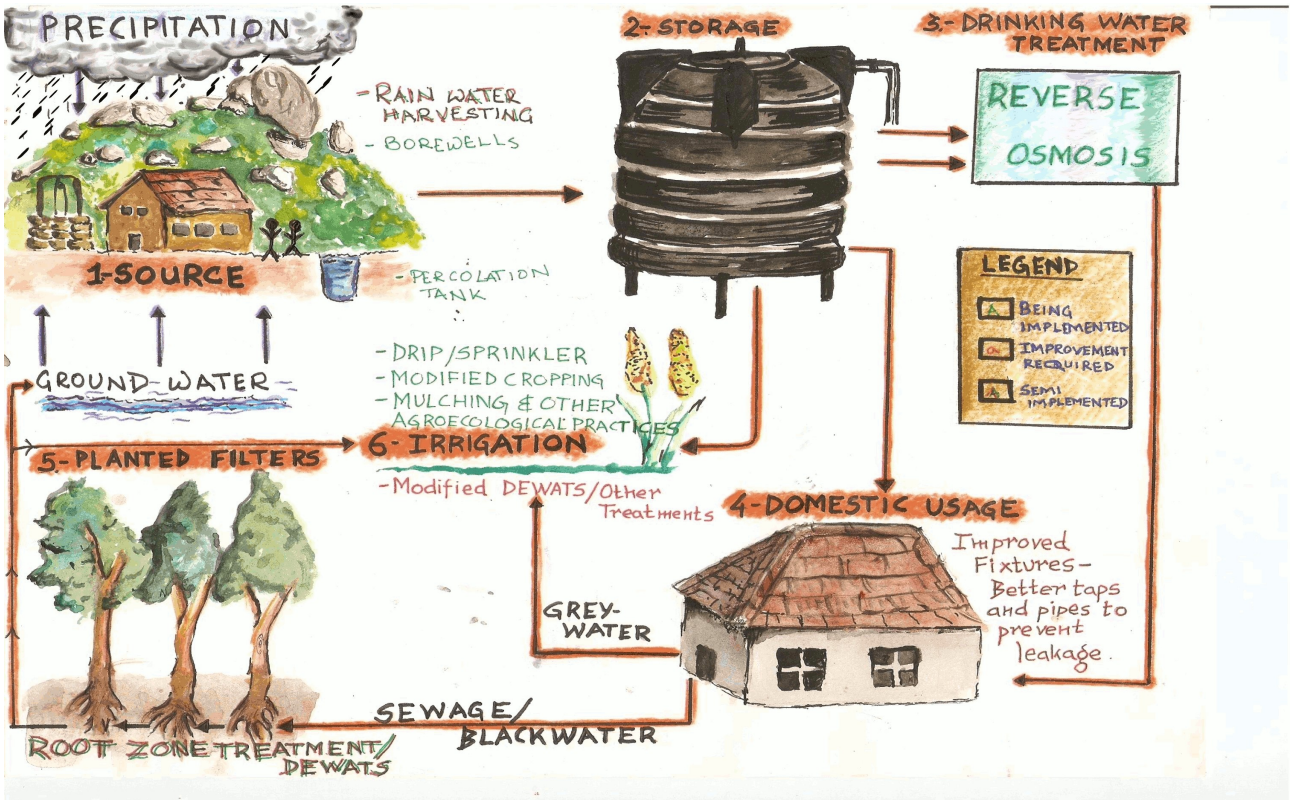

Figure 3: Schematic of the water cycle in Rishi Valley. Green text shows water conservation measures being implemented and red text marks areas that need improvement.

Water on campus is primarily drawn from borewells and while percolation structures recharge these wells another effective conservation measure at source is rooftop rainwater harvesting. According to a study commissioned by the school, it has been calculated that rainwater harvesting could contribute to around 25% of our daily water requirement [11]. Although this attempt has been made to collect rainwater, there is not a very extensive rooftop rainwater harvesting system functioning in the community. And of the two functional rooftop rainwater harvesting systems, only one of them has a storage tank at the point of rainwater collection. This has been due to the cost implications for large secure, storage tanks. Efforts are however underway, to try and cover as many rooftops on campus as possible under the rainwater harvesting scheme. The Valley also recieves short spurts of rain which are followed by intense sunlight, and most of the water harvested in percolation tanks during these spurts of rain are evaporated due to the intense sunlight. This is where rooftop harvesting could be effective.

The RVEC community has also taken the initiative of starting a student run activity called “Getting

Your Hands Dirty!". As part of this effort, students (Classes IX to XII) set up check dams, contour trenches to help collect water, clear water channels by desilting them as well as removing vegetation that may interfere with water flow to the percolation ponds / tanks. Therefore one of the ways in which the community can collect rainwater more efficiently would be by setting up storage tanks at the point of collection.
The water from the rooftops and borewells is conveyed to overhead storage tanks on the RVEC campus. From here the water is sent for the various uses such as domestic consumption, laundry, kitchen and dining hall, agriculture etc. Drinking water is passed through a reverse osmosis plant where the water is purified to meet the BIS drinking water quality standards. At all of these stages water can be reused and /or recycled.

Water Conservation Through Maintenance
As discussed earlier, one of the most critical issues that needs to be addressed is timely and effective maintenance of water systems on campus. Leaky taps, broken pipes or disused tanks must be fixed at the earliest. The Building Department on campus is typically notified and they address the complaint immediately. Students must also take more responsibility and participate in notifying the authorities as soon as they notice any loss of water due to poor fixtures. This also applies to water meters – the device used to measure the amount of water used in a day. The working meters are 40 in number, while the malfunctioning ones are 22; and compounding this there are 7 or more structures completely devoid of water meters [6]. If this situation is attended to, at least we will have a clear idea of the water consumption within campus.

Water Conservation during Consumption
At the consumer's end e.g. in the school kitchen, residences, hostels, water saving devices could be installed in a phased manner. These could include water saving taps with small nozzles, dual mode flushes so that excessive water is not consumed in toilets etc.

RVEC has an efficient water storage system which apparently has not gone dry in the past 15 years. Therefore, it appears that there are no major improvements, apart from routine maintenance, that need to be made in this part of the water cycle.

Drinking water is treated prior to use by using a reverse osmosis system where some percent of the input water is discharged as waste/ reject stream since it contains a very high concentration of salts extracted from the water. Research done on this treatment process indicated that there are three main factors that define the percentage of recovered water: the quality of the membrane, the back pressure and naturally, the quality of input water. In most households, as it turns out, due to low back pressure, recovered water is as low as 15%. On the other hand, in large industries with high back pressure but low membrane quality, the yield of recovered water increases by 45%[12]. In RVEC the percentage of recovered water varies but is in general high at a rate of 75% recovered water[13]. This is achieved mainly because of the high quality of the membrane and the input water also being of good quality apart from the moderately high level of total dissolved salts.

Apart from water for human needs, water is also needed by for cultivation and livestock. While there are numerous benefits to growing organic food locally, we also need to examine the existence of the dairy and its benefits to the campus. One way to significantly reduce water usage would be to procure milk from farmers outside the campus and shift the dairy to local breeds that have much less water needs and are also hardier.

One of the best ways to improve the water situation in the Valley is by reusing and recycling the grey water and sewage to the maximum extent possible. Wastewater from the residences, hostels, dining hall and other places can also be reused / recycled completely. Estimated quantity of sewage per day is 24.5 kL and washwater (from bathrooms and kitchen) is about 30 kL per day. On campus

all the sewage (black water) is treated in septic tanks except for a block of boys' hostels. Here the sewage and the washwater from the bathrooms (grey water) is treated using a Decentralised Wastewater Treatment System (DEWATS) which is a combination of physical and biological treatment methods [2]. The treated water is used to irrigate fruit trees in the Estate. The performance and viability of this system is being examined for replication in other parts of the campus.

At present the grey water from most hostels, and residences is being re-used (without treatment) for the irrigation of fruit trees including the mango grove. Some staff members too use their waste water for plants and not leaving it to join the sewage.

While researching possible solutions for better water management, we looked at another highly sucessful community that has learnt to use water effieciently – Auroville in Pondicherry. Auroville uses an ingenious water recycling technique that involves waste water treatment systems known as 'Planted Filters". These were natural functioning systems where grey water passes through the root zone area of a series of plants that clean the water and deliver a high quality effluent.These planted filters use a large amount of space, but in Rishi Valley, this would not be a disadvantage as these planted filters could be beautifully landscaped into almost any enviroment. Auroville operates over 40 of these planted filters in larger systems known as Root Zone Treatment Systems [14].

A similar root zone treatment system is used as part of the DEWATS plant for treatment of sewage at RVEC. Here *canna* and *gladioli* are grown and the sewage that has been treated by a microbial treatment system passes through the root zone of these plants to emerge as quality water for irrigation. This kind of root-zone treatment could be used for all the buildings on campus so that potentially all the black water could be partially cleaned up and reused.

At present our washwater is used un-treated for irrigation. However, RVEC intends to cover all agricultural areas on campus with drip irrigation to reduce losses due to evaporation. To enable this the washwater will have to be treated to remove any suspended solids. Various options including Root Zone Treatment are being explored in this regard.

Another promising option is the concept of Living Machines [15]. Using this concept, one can look at waste water recycling in terms of the ecosystem. A living machine can be thought of as a constructed wetland with several different plant and animal species actively filtering the water. A conventional wastewater recycling unit produces toxic byproducts that need to be segregated. However using the living machine concept, only biomass is created and heavy metals and other manmade chemicals can be segregated. One can think of it as an efficient way of letting nature do the work of cleaning sewage and greywater. At present we do not know of any community in India that has incorporated this concept as part of water recycling. We feel that Rishi Valley could be enormously benefited if this system was implemented here and could also serve as an important pilot test for other communities that could benefit from these systems.

In summary, the points in the RVEC water cycle where recommendations for better management are being suggested include:

(i) more widespread rooftop rainwater harvesting and collection;
(ii) timely and routine maintenance of water fixtures and replacement with more efficient structures;
(iii) gradual replacement of the septic tanks with Planted Filter systems like DEWATS for treatment of sewage and recycling using the Living Machines concept.

7.0 Critical Summary

Water is the most precious resource in Rishi Valley – not just for the school, but for the entire Valley that is dependent on it for its life and livelihood. **Water is a common property resource that all of us in the Valley share and must therefore be managed by and for all the communities in the Valley!**

Given this interdependence, efficient management of this resource is not just important **but essential** for our existence. RVEC is possibly the largest community in the Valley and therefore consumes a significant share of this resource. Hence it is our responsibility, as a community to take all the necessary measures to reuse, recycle and reduce water consumption to the extent possible. We need to lead by example.
As discussed in the essay, the water stress on the RVEC Campus is due to three main factors: (i) the geographical position of the Valley and its seasonally low rainfall; (ii) poor infrastructure and low recylcing percentage and (iii) awareness among campus residents – students, staff and others. While we are conscious of the way we use water, as shown in the essay, there is a lot more that we can do to use this resource sustainably so that the livelihood of the community around us is not compromised.

Through this essay we have tried to present simple, yet innovative practices through which water can be used judiciously. We have also tried to show how by mimicking natural systems "Living Machines" can be set up to reuse and recycle water. We hope to implement the various measures recommended in our essay effectively so that we can be a model community where the water cycle functions as a "closed-loop." This is the only way forward for the Valley and its people whose lives are intricately shaped by WATER.

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