Neere Krushiya Moola

(Water is the very source of agriculture)

An "Earthian" Project

by the students of

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Note to the Earthian Group

The total numbers of students who are participating in the Wipro Earthian 2013 from Prakriya Green Wisdom School is 22. We were divided into 3 vertical groups. For the data collection for activities listed under Section A, we also divided ourselves into three horizontal groups (these horizontal groups had a mix of students from the 3 main groups). These horizontal groups worked on data collection/experiments for Water Demand, Water Quality and Water Trail. The data collected was analyzed and findings were shared across all the three vertical groups. *Thus, the figures for water trail and demand for water in the school and the experiments done for water quality are identical for all three groups.*

However, each vertical group worked independently on the following:

- The analysis and interpretation of data collected.
- Conclusions based on our findings/analysis required for Essay 1 (Section B).
- Linking our findings to the macro theme we have chosen for Essay 2 (Section B).

Since we don't have a water meter, for some of the activities listed in the activities booklet, we interviewed multiple sources and arrived at our own estimations. We interviewed

- Founder trustee of the school
- Campus manager (current & former)
- Garden Coordinator
- Kitchen/Canteen Coordinator
- Gardener
- Water pump operator

Thanking you,

The student participants

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SECTION A. PART B - ESSAY 1

1 INTRODUCTION

What runs but has no feet? What roars but has no mouth? What runs and never gets tired? Of course, it's water! It is water that we depend on for life. Over the years, the reverence people had for water has been replaced with neglect and indifference. When we came to know that the theme for this year's Earthian Project is water and its sustainability, we were overjoyed; nothing seemed more pressing for students to engage with and learn about in the context of modern day India. If it's not a draught in Maharashtra, it's a flood in Uttarakhand. If it's not a cyclone in Orissa, it's a tsunami in Tamil Nadu.

This project enabled us to look at the different hues and shades of water as it flows in and around our campus. Measuring the quality and demand for water, and finding its path in our school would give us insight on how much we take away and how much we give back. We would discover what this elixir of life has to go through before it reaches our taps. Hence, in this essay, we aim to understand our relation with water in the context of our school, Prakriya.

2 Water Demand

There are seven main end-use locations in our school. We used the primary survey technique to collect data on water usage from these locations. The findings are given in the subsequent sections.

(See table on the next page)

Figure 1 – Quantity of water (in litres) consumed per working day)

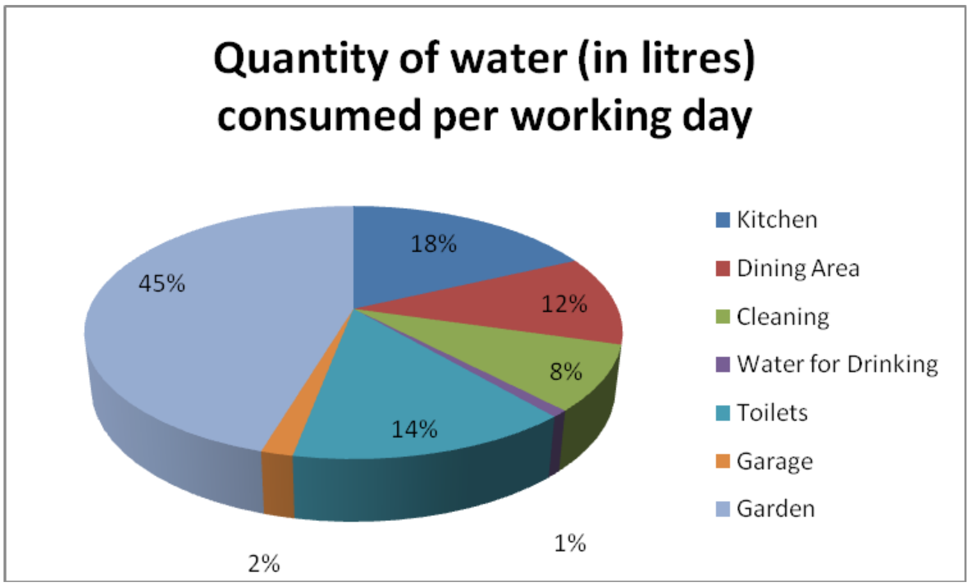


Table 1-Total water usage per working day at different end use locations

End Use Location	Consumption per day (in litres)	Percentage	Our observations	Questions we have
Kitchen	4010	18%	Most of the water is used for cooking rice which is made every second day. This consumption could be reduced by cooking millets more often.	How much water is used in restaurants for cooking compared to our school?
Dining Area (Canteen)	2,533	12%	The water in the canteen is mostly used for washing plates by students and teachers. The staff tries its best to use less water while washing plates the second time.	Despite using water carefully, our school uses lot of it. Then what would be the water consumption for washing plates in hotels, where the taps run continuously?
Cleaning	1,860	8%	Though the staffs try to use minimal water, the students use more water during community service.	Is there an alternate method for swabbing? Swabbing requires a full bucket of water; though all the water is not used, all must be thrown out as it becomes dirty.
Water for Drinking	190	1%	It surprised us that drinking water consumption is the least.	How much water is used for drinking nation-wide?
Toilets	3165	14%	We do not have flushes in most of the toilets. Therefore, our water consumption in toilets is reduced.	How much water does a government school use compared to private schools?
Garage	360	2%	We try our best to wash our buses with damp cloth.	Do our buses need a wash every day?
Garden	10,120	45%	▪ Provides fruits & vegetables to canteen – watered on alternate days; ▪ 500 odd trees which we don't water on a regular basis	▪ Should we examine whether we need to plan more water prudent plants? ▪ How much water does agriculture sector consume nation-wide?
Grand Total	**22,258**	**100%**		

Our school uses most water for the garden where we grow vegetables for our kitchen. Our school kitchen provides vegetarian food made from organic vegetables. In the dining area, water can be saved if the students and teachers do a good job of cleaning the plates- then, they needn't be rewashed. We need to raise awareness for this- perhaps announce it in the assemblies, and hope that everyone co-operates.

The average per capita consumption of water in the toilets is 4.5 litres- this number could be reduced. There aren't many flush toilets in our school- the existing ones can be replaced with eco-toilets which require much less water, as seen in our sister organization 'Bhoomi'.

Another aspect we can consider is washing buses not more than thrice a week. The leakages around school are checked at regular intervals- currently about 66 l of water is lost daily (see appendix).

The per capita consumption of water in our school is 32 l per working day. Though this may not seem like a large quantity, we must remember that this usage is only when we are in school. A member of our group did a survey in her house and found that a family of four consumes 1000 litres of water per day- that's 250 litres per person.

The water demand in our school is not quite a lot, considering that we do not have a swimming pool. We do not have lawns for our football field, and the little grass that's present on it grows naturally. Hence, overall, our water demand seems sustainable. Our practices do reflect consciousness to some extent, as will be discussed next.

3 Water Trail

3.1 Our Water Supply Story

The table below lists the sources and the amount of water used by our school on a daily basis.

Table 2 - Sources and amount of water used by the school on a daily basis

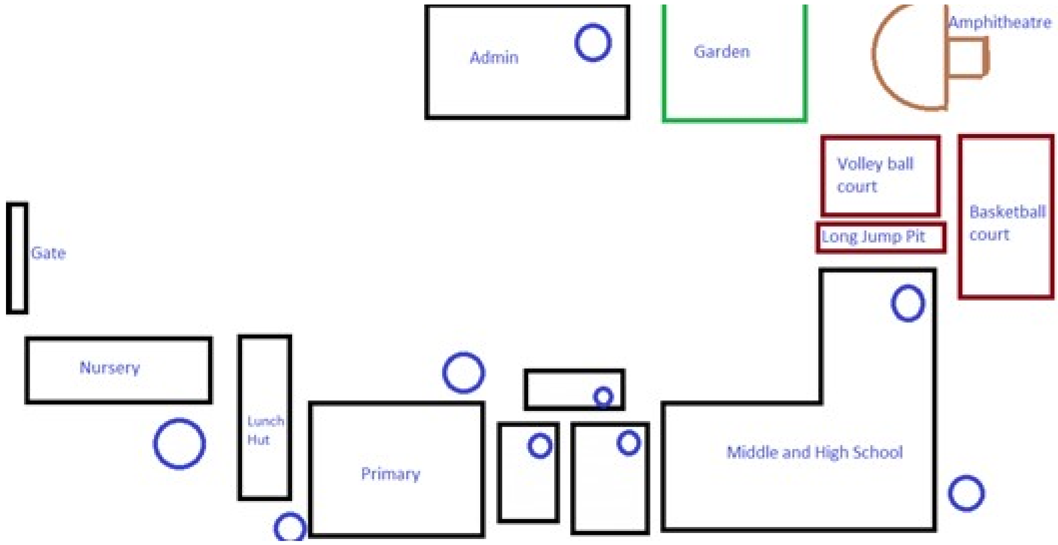
Sources	Amount of Water in Litres
From the bore well	18,600*
Rain water	7,000
Total	**26,000**

*Note: * 5200 litres out of these 18,600 litres is recycled and is used in the garden*

Water is pumped out of the bore well daily for approximately ten hours. We get water at a depth of 360 feet. It requires about 50 units of power to function for ten hours and every unit is Rs. 3.5.

Another important source for our school's water supply is rainwater harvesting. Bangalore receives 800mm of rain annually and this rain is not distributed evenly over the 365days. We get fairly good rains for only 5- 6 months of the year. During "no rain" periods, we depend more on our bore well. On days of excessive rain, the storage tanks overflow; so we need to have larger storage capacities. However, there is a recharge pit at the far end of the campus- the lie of the land is such that the rainwater run off collects in the recharge pit, which can hold 618 kl of water.

Figure 2- Location of rainwater harvesting tanks in our school



The table on the next page provides details on our rain water harvesting potential.

Table 3- Calculations of our rainwater harvesting potential

Type of Surface	Area in school	Total Square metres	Run off coefficient	Calculation	Result in Kilolitres
Roof	▪ Admin Block ▪ Nursery School ▪ Primary School ▪ Middle School ▪ High School	2795 m^2	0.9	2795*0.9*0.8	2012.
Hard surface	▪ Football field ▪ Basketball field ▪ Volleyball field ▪ Sandpit	2897 m^2	0.4	2897*0.4*0.8	927
Forest	▪ Devara Kadu (Sacred Forest) ▪ Long jump pit	1080 m^2	0.2	1080*0.2*0.8	173
Hard and soft surface	Amphitheatre	475 m^2	0.6	475*0.6*0.8	228
Soft surface	Remaining area of the school	10964 m^2	0.4	10964*0.4*0.8	3510
Total = 6850 kl					

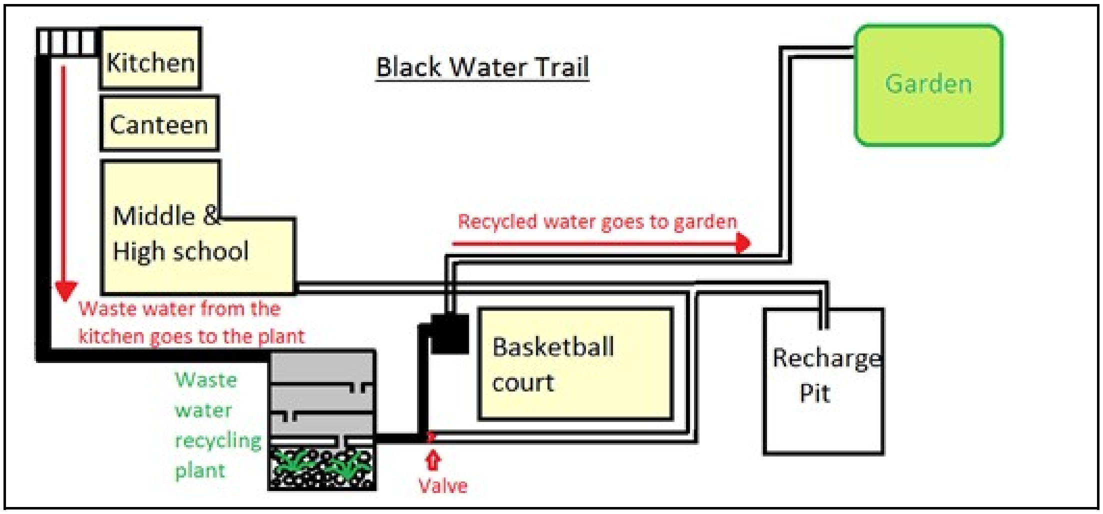
The total rainwater harvesting potential for our campus is 6850 kilolitres annually. We are harvesting only 1260 kilolitres annually. Though we haven't reached our full harvesting potential, the water that collects in the recharge pit replenishes the ground water table.

3.2 Waste Water Recycling

Another important aspect of our water trail is our waste water recycling.

The water from the kitchen goes to a waste water recycling plant. The water flows through a series of mesh-like structures which separate organic wastes. It collects in three settling chambers so that all the organic particles settle down and the oil collects on top. It then passes through a chamber containing jelly rock (kadappa stone), *reech* and *jumbo* plants which only water to grow. The stones are of 20mm and 40mm. When the entire process is done, the water still has salts, organic matter and bacteria. Ideally we should have more chambers, but as the water is being used for the garden, it's clean enough- this is because we use soap nut to wash vessels. It doesn't have any chemicals which may aversely affect the plants.

Figure 3- Depiction of black water trail/recyclable waste water trail in our school



3.3 What is done with the waste water generated from the toilets and cleaning areas?

All our waste water is discharged into a septic tank. The waste decomposes and the water is absorbed by the ground, so the septic tank will take years to fill up. It has not been cleaned out for the past ten years as it is not filled up.

The water story is not complete without looking at another crucial component namely, water quality.

4 WATER QUALITY

We conducted experiments suggested in the activity booklet and the results are given below:

Table 4- Test on properties of water

Physical Parameters	Recyclable Waste Water	Rain Water	Drinking Water	Tap Water	Pond Water
Colour	Greyish black	Mostly clear	Clear	Clear	Muddy
Odour	Pungent, stinky odour	Odourless	Odourless	Odourless	Odourless
Turbidity	Very turbid	Slightly turbid	Clear	Clear	Slightly turbid
Suspended Solids	Suspended living matter like worms and leaves	Few suspended particles like mud and dirt	None	None	Dirt, leaves, living matter like worms and tadpoles
Temperature	23 °C	24 °C	23 °C	24 °C	24 °C
pH	8	7	7	7	7
Sources	Kitchen waste water is recycled in the waste water plant	Rain water is collected in several rain water harvesting tanks located all around the school campus	Bore well water is purified via aqua guard	From the bore well	Mostly rain

4.1 Test for Bacteriological contamination – Test for pathogenic bacteria

The table below details out the results of the test for pathogenic bacteria-

Table 5- Test for pathogenic bacteria

Samples	Observation	Conclusion
Rain water before SODIS	▪ Turned black	▪ Contaminated with pathogenic bacteria ▪ Not fit for consumption
Rain water after SODIS	▪ Turned clear brown	▪ Not contaminated with pathogenic bacteria ▪ Can be consumed
Recyclable waste before SODIS	▪ Turned inky black	▪ Contaminated with pathogenic bacteria ▪ Not fit for consumption
Recyclable waste water after SODIS	▪ Turned black	▪ Contaminated with pathogenic bacteria ▪ Not fit for consumption
Tap Water	▪ Turned greyish black	▪ Contaminated with pathogenic bacteria ▪ Not fit for consumption

4.2 Test for fluoride, chlorine and hardness

Table 6- Tests for fluoride, chlorine and hardness

Characteristics	Desired amount (mg/l)	Tap water of Prakriya (mg/l)	Drinking water of Prakriya (mg/l)
Fluoride	1.5	0.6	0.6
Chorine	0.2 (min)	0	0
Hardness	300-600	400	[not tested]

The quality of our school water is not bad. The quantity of fluoride and chlorine are less than the permissible amount. Our tap water contains pathogenic bacteria while our drinking water does not. The hardness of the water is alright. Altogether, our school drinking water is potable.

5 CONCLUSION

Water demand, supply and quality are very closely linked or interconnected. Due to the increasing demand, the quality of water gets impact. Due to the ever-increasing population, water has to be supplied more regularly even to the remotest places. When water is supplied to so many places, spread far out, it is difficult to maintain the purity of it. As the demand is increasing, India has to dig into her groundwater reserves more than ever before.

In our school, we try to minimize our water usage as much as possible. We use alternatives to the bore well water, such as rainwater and recycled water. However, global warming is catching up to us, as the ground water table continually decreases. With the increasing number of apartments coming up around the campus, we don't know for how much longer we can depend on the bore well.

We noticed a factor which matches up with water usage globally. Most of our water goes into the garden from where we get the vegetables for our canteen. This proves that even the smallest of communities invest most of their water resource into agriculture. In India about 80% of water is used for agricultural purposes. Water usage in agriculture is a pressing issue for present day India. We decided to look into this matter further and chose agriculture as our topic for the second essay.

PART B - ESSAY 2

1. Introduction

Agriculture began in India at around 9000 BCE. The advent of agriculture paved way for man to start leading a settled life. However, the agricultural practices have changed over time.

Table 1- Population growth from the beginning of the human era

Year	Population
50,000 B.C.	2
8000 B.C.	5,000,000
1 A.D.	300,000,000
1200	450,000,000
1650	500,000,000
1750	795,000,000
1850	1,265,000,000
1900	1,656,000,000
1950	2,516,000,000
1995	5,760,000,000
2011	6,987,000,000

(Source: Population Reference Bureau Estimates)

The above table shows the population growth over time. In 8000 B.C., the population was 5,000,000, and the supply of water exceeded the demand by a fair amount. Today, the population has shot up to almost 7 billion. The population of India itself is about 240 times the numbers estimated during that time. **The question then, is how has this impacted the demand for water and food?**

This rapid increase in population has a direct impact on all the natural resources we depend on- including water. As quoted by Albert Szent-Gyorgyi, "**Water is life's matter and matrix, mother and medium. There is no life without water**." All living things depend on water for sustenance and survival.

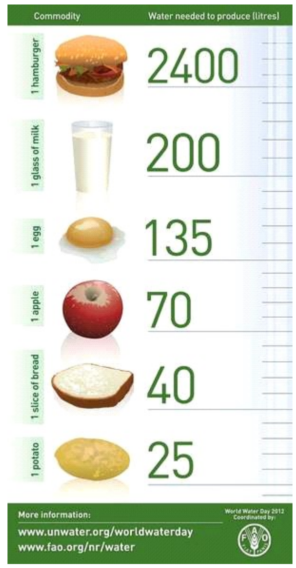
The activities we did as a part of this project opened our eyes to certain realities which we had not given much thought to. We had originally assumed that water consumption in our school would be most in the wash rooms; it surprised us that our organic garden which grows part of our daily fruits-vegetable requirement consumes close to 45% of the total water demand. This made us wonder about how much water a country like India uses up to grow the food that is needed to feed her 1.5 billion children.

"May the rains come on time; may the earth bend with the weight of food grains; may this land be free of scourge; may the learned be fearless; may the poor become wealthy and may all live a hundred autumns; may the childless have children and whose with children have grandchildren. Lord, give all people a life of well being."

This Vedic prayer seeks the blessings of the Lord to enable us to lead content lives. From time immemorial we have known that the root of this wellbeing lies in water and agriculture. What is the status of water and agriculture now; and therefore, the state of our wellbeing?

The problems that we face today in agriculture are overwhelming- 22% of the Indian population which is Below the Poverty Line goes hungry to bed every night. One of the clear links we discovered during the course of our research could be traced back to water. **Though the daily drinking water requirement for a person is 2 – 4 litres, it takes 2000 – 5000 litres to produce one person's daily food.** For example, the figure below represents the water usage in litres for different food items.

Figure 1- Water usage for different food items



(Source: www.unwater.org)

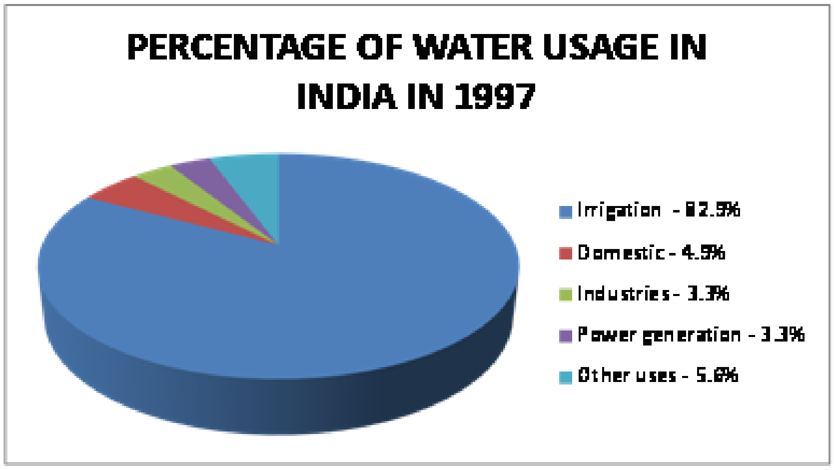
However, we later learned that 82.9% of the water resources are used for irrigation/agriculture in our country, and we were startled. A lot of water is being allocated for agricultural purposes, as seen during the First Planning Period of the 1950s. Where did we go wrong then, that our country struggles to feed its children?

We therefore decided to explore the link between food, agriculture, and water usage, keeping in mind the question of sustainability in the long run.

2. WHAT LED TO OUR CURRENT WATER NEEDS FOR AGRICULTURE?

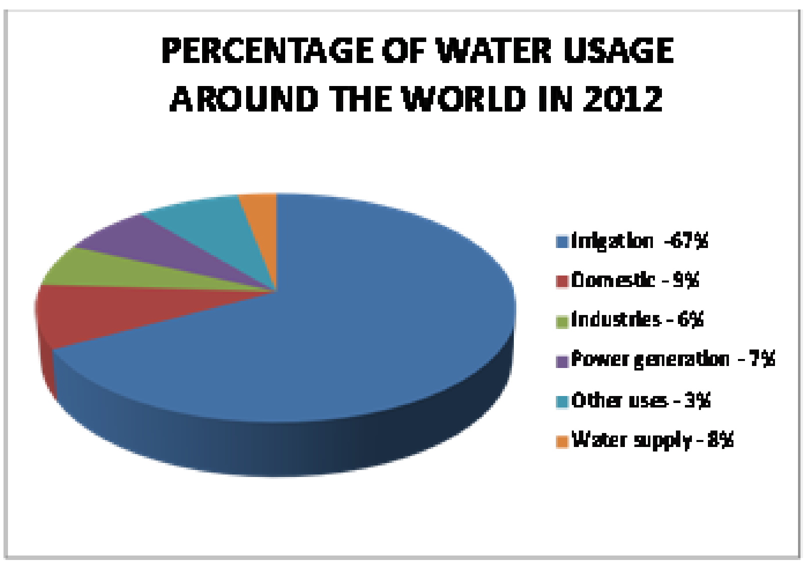
The following figures 1 and 2 establish that irrigation is the primary guzzler of water in India, as well as worldwide. Table 2 illustrate that irrigation/agricultural sector tops the nation's water consumption.

Figure 2 - Percentage of water usage in India per sector



(**Source:** *Understanding Environment- water use pg 79*)

***Figure** 3- Percentage of water usage around the world per sector*



(Source: www.climate.org)

We found ourselves asking these questions:

- Has it always been like this in past 9000 years of India's agricultural history?
- Why is there such a big demand for water in irrigation?

Traditionally, the cropping pattern in India was suited to the prevailing geographical conditions (like elsewhere in the world) and was largely rain fed. With the coming of the British, the focus shifted from a predominately subsistence agriculture to commercial agriculture. Food crops such as ragi, bajra and other pulses were replaced with cash crops such as indigo, sugarcane and cotton.

After independence, food security for a rapidly growing population loomed large before us. India, at that time was heavily importing food. More than 60% of the people were below poverty line. Witnessing the success of the Green Revolution in western countries such as USA, our policy makers decided to adopt those methods for us too.

This policy shift transformed India from a food importing country to a food exporting one, but in this triumph there were also tragedies. We will examine the fallouts of Green Revolution from two perspectives:

- The increase in demand for water due to change in cropping pattern
- The contamination of surface & ground water which affected water availability per capita

3. FALLOUTS OF THE GREEN REVOLUTION

3.1 The increase in demand for water due to change in cropping pattern

- Water prudent crops such as millets and oilseeds were replaced by water guzzling crops such as rice and wheat. (See table below)

Table 2 - Comparative rainfall requirements of various crops

Crop	Rainfall requirement (in mm)
Sugarcane	**2000-2200**
Rice	**1200-1300**
Cotton	**600-650**
Maize	**500-550**
Groundnut	**450-500**
Sorghum	**400-500**
Bajra	**350-400**
Wheat	**350-400**
Ragi	**350-400**
Pulses	**300-350**
Sesame	**300-350**

(Source: http://earth360.in)

- Let us take a recent example of Maharahtra. The state got a loan from the World Bank in 2003. The loan was given under the condition that the farmers start cultivating rice instead of sorghum. "One acre of rice uses as much water as three acres of sorghum. For the same amount of water, sorghum provides 4.5 times more protein, four times more minerals, 7.5 times more calcium, and 5.6 times more iron, and can yield three times more food than rice." Furthermore, Maharashtra also had to shift to the cultivation of sugarcane, requiring 2500 mm of water. ***Sugarcane is cultivated on only 3% of the land, but accounts for 80% of the irrigation water.***
  (Source-Vandana Shiva-Turning Scarcity into Abundance)

- Traditional varieties of rice and wheat were replaced by dwarf HYV crops which require three times more water. As a result, demand for irrigation went up from 20% - 30% to 200% - 300%. This intensive use of water has resulted in water logging and salinization of land. In India, 10 Mha of canal irrigated land have become water logged and another 25 Mha are threatened by salinity.

- Shifting from growing one-crop per season per year (a practice that is largely dependent on the monsoon) to double cropping season also impacted water consumption. In order to provide for the increased demand for water, large scale irrigation schemes were implemented. All the big dams we see, the extensive canal network and imprudent mining of groundwater through tube wells and bore wells…. all had its beginning then.

- Due to rampant groundwater mining, the water table is dropping at an alarming rate. In Gujarat, Punjab, Haryana, Tamil Nadu and Rajasthan, the groundwater mining is above the national average.

3.2 Contamination of surface & ground water

Ever since the beginning of the Green Revolution, pesticides and fertilizers used to facilitate the growth of crops have contaminated surface water. While large quantities of them remain in the soil, traces of them are washed into the nearest water bodies when it rains; or with irrigation waters. Hence, the underground water as well as surface water are contaminated and deemed unusable.

- Due to increasing nitrate and chemical levels in soil, nutrients in plants are decreasing rapidly because the soil Ph is exceeding 7.5. This also affects the activity of soil micro organisms and other life that actually help nurture the soil. Fertilizers used to add fertility to the soil kill organisms. Less organisms result in lesser nutrients in the soil, so more fertilizers are used- hence the vicious cycle goes on.

If we trace our water story, the coming of the British and the post independence policy shifts has brought us to the current day scenario of overuse and mismanagement of our water resources. The prediction for the future therefore is acute water stress.

India’s water usage will go up in the next 34 years compared to how it was in 2000 (See table on the next page).

Table 3- Comparative water usage in different sectors

Year	Agriculture	Industry	Domestic
India	Billion Lit/Day		
2000	**1658**	**115**	**93**
2050	1745	441	227

(Source: www.indiawaterportal.org)

Global warming also poses a threat to water availability which will be discussed next.

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4. GLOBAL WARMING

The rising temperature and changing rain fall patterns which are the consequences of global warming will have a **direct bearing on food production and food security.**

1. Due to the increase in carbon emissions, the temperature of the Earth has risen, and it will continue to rise even in the future, as seen in the table below.

Table 4 - Estimates of future levels of CO_2

Year	CO_2 (parts per million)
2000	369
2010-2015	388-398
2050-2060	463-623
2100	478-1099

(Source: **http://www.slideshare.net/soumyashree85/global-climate-change-its-impact-on-indian-agriculture-presentation)**

Hence, there is more evaporation of water. We do not usually look at this as something to worry about as what goes up must come down, right? This is actually true; however, the proportions of the amount of water evaporated and received are not the same. Regions prone to rainfall are flooded (example in India- entire north India) while regions which receive less rainfall battle droughts. This is due to shifts in wind and ocean currents changing rainfall patterns. The monsoon winds- that 60% of Indian agricultural land depends on- will become more unpredictable. Due to global warming, the areas near the poles will become wetter while those near the equator will become drier. India being in the tropics will probably become drier, prone to long spells of droughts followed by intense spells of rain. Basically, rains will become unpredictable.

2. As a result of global warming, there may be a decline in availability of fresh water because-
    - Shrinking of glaciers and snow caps will threaten the availability of fresh water.
    - Due to rise in sea level the saline water may intrude into the fresh water sources.
    - Groundwater is replenished by rain- if rains become unpredictable, ground water will not be replenished. Hence, the water table will drop.
        - According to rough calculations, the average drop of the groundwater levels by 1 meter will increase India's carbon emissions by 1-4.8% because the withdrawal of the same amount of water will require more fuel which again gets us into an never ending loop: ground water table falling, more energy being required to draw water, which means more fuel will be needed, which means more CO_2 emissions, adding to global warming…the cycle repeats (See table below)

Table 5 – The large number of tube wells in Punjab that contributes to global warming

Year	Tube wells (in lakhs)	Tube wells (in lakhs)	
	Diesel operated	Electric operated	Total
1970	1.01	0.91	1.92
1975	3.04	1.46	4.5
1980	3.2	2.8	6
1982	2.9	3.33	6.23

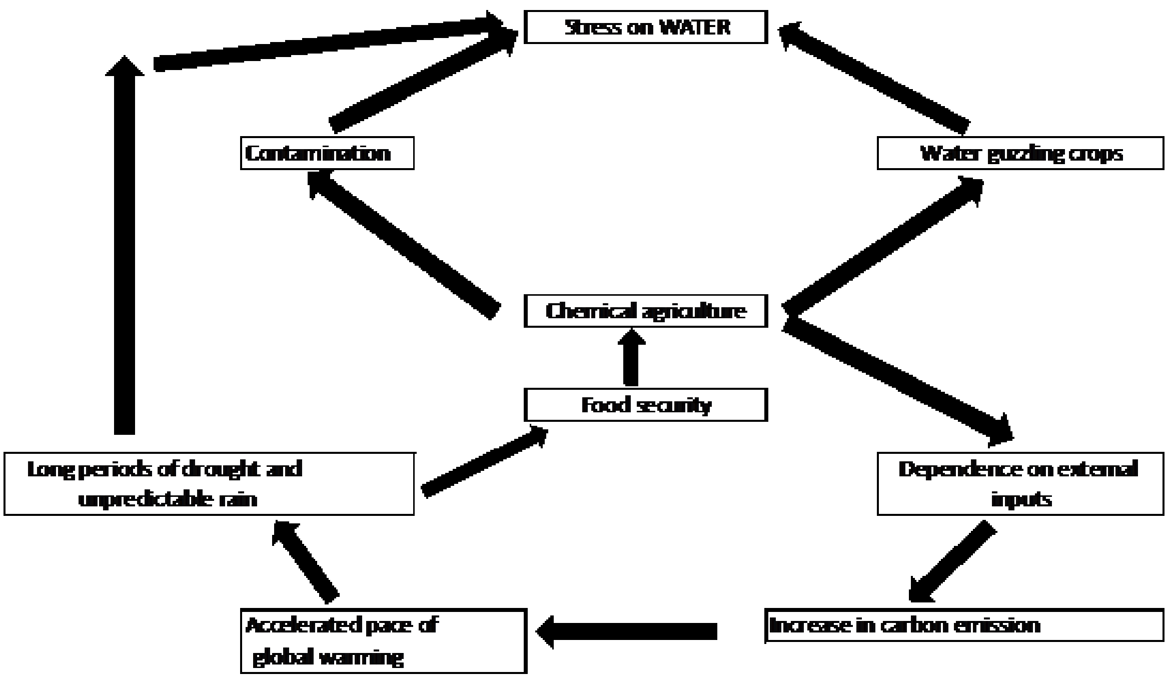
(Source: Violence of the Green Revolution, page 141)

3. Due to global warming, the moisture content of the soil decreases. Hence the irrigation demand increases, which also gets us into a similar loop.
4. Global warming is also posing as a mammoth threat to the foods security situation in India with recurring and severe droughts and ravaging floods engulfing the arable land. Rising temperatures on the Tibetan Plateau are causing the melting of the Himalayan glaciers. Over the years, this will affect the water flow of all our major rivers, thus affecting agriculture.
5. Green Revolution promoted the unnecessary use of machinery in agriculture. This led to the increase in usage of fuel, contributing to global warming.
6. Furthermore, due to green revolution chemicals are used generously. Manufacturing these of these chemicals leads to global warming.

5. CONCLUSION

Agriculture is a practice not new to the human race- the growth of a tiny sapling puzzled the early man, but he turned what he was confused about into a specialty in the course of time. With the coming of the Industrial Revolution and the Green Revolution, man found the easy way out for cultivation. Why use natural manure? Why grow different varieties of crops to replenish the nutrition of the soil when fertilizers can take care of the soil fertility? Why grow seasonal crops or those which need high rainfall when water for irrigation can be bought at subsidized rates? All these have put an enormous stress on water.

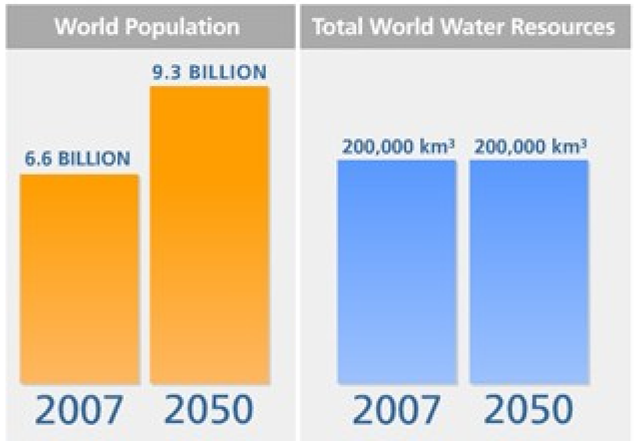
Figure 4- Stress on Water and Food Security due to Chemical Agriculture



(Source: Prakriya group students)

The figure above summarizes how the Green Revolution puts a stress the water resources. The very reason for implementing Green Revolution methods was to achieve food security. As the figure clearly illustrates, the main objective of Green Revolution has been lost and the collective wellbeing of billions is at grave risk! With the population growing exponentially, there was a rush to provide food security post independence. Green Revolution was introduced in which High Yielding Varieties of water guzzling crops became prominent- this was done to bring about food security by increasing productivity in the short run. We did not foresee the repercussions that would eventually play out in the long term. So, what is the way ahead? How will we get food on the table for the increasing population, while the water on the planet is a constant?

Figure 5 – Graph of World Population and Total World Water Resources: 2007 vs. 2050



(Source: www.unwater.org)

Let us begin the process of unlearning, and start learning from nature.

"Would it not be well to consult Nature, for she is the most experienced planter of all!"

- *Henry David Thoreau*

We would like to end this essay with a poem written by us, which was inspired by this project.

TROUBLED WATERS

Once upon a time, there was surplus water and none had less,

But now we face an acute scarcity because of our shortsightedness.

An example of shortsightedness is the adoption of Green Revolution,

To produce food for our entire population.

Feeding the population is not bad;

But it raises crops for which fertilizers are a fad.

The crops drink up the water and pollute it as well,

Leaving behind the soil all but well.

Global warming comes in and adds to the gloom,

If something isn't done we're headed for doom.

We must do something and something fast,

Before the consequences are too vast.

And why not start with organic farming, as we need it best,

Without which we cannot rest.

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9) http://www.climatehotmap.org/global-warming-effects/water-supply.html
10) http://www.angelfire.com/nh/cpkumar/publication/CC_RDS.pdf

Miscellaneous Articles:

1) Vandana Shiva, Turning Scarcity into Abundance
2) Research paper- From the Farm to the table (Earthian Paper, 2011)