

### Land Constraints:

#### IH Test Preparations

Reasons for Land constraints:

- Increasing Populations
- Greater demand in Housing
- Greater demand in jobs, resulting in more land for industries
- Greater demand for a robust transport system
- Greater demand for agricultural land
- Greater demand for recreational areas

In addition, only 30% of the Earth is land. However, lesser than 30% of the land is arable and usable since some and such as marshes are constantly water-logged, while some land has been set aside for a specific purpose such as water catchment areas which are large areas of forest used to channel water into reservoirs or as military purposes. More than half of Singapore's land is used for water catchment and military purposes.

### Responses to Rising demand for Land:

A country/city has a limited supply of land. When the supply of land cannot meet with the growing demands of land, price will soar. This is due to the fact that some users is willing to pay a higher price for the land.

-Increasing the price of land—a one bedroom apartment costs more than 1600 to rent per month in Tokyo

By increasing the price of land, more people will be discouraged to use the land, hence reducing demand.

### Increasing Supply of land:

Land clearance- The fastest way to meet the demand for land. Land clearance is the process whereby empty plots of land are created for various land use. This can be carried out by demolishing old buildings or clearing forests which is also known as deforestation. When the land has been cleared, land is freed up to for buildings and other facilities. However land clearance has negative impacts. When forests are cleared, it can kill many animals and cause mass extinctions. The equilibrium of the delicate food chain could also be toppled.

### Land Reclamation:

Land reclamation is the process of obtaining land from water-logged areas of land. Firstly piles are forced into the seabed to ensure that the foundation is stable. Next sand is loaded into the seabed and left there till it is needed. A sand wall is built around the area of sea to be reclaimed. The sand is then sucked up from the seabed and loaded into the enclosed area and compressed. A granite wall is also built around the sand wall to prevent erosion by the waves. Trees and other vegetations are then grown on the reclaimed land to prevent soil erosion and is laid to rest. The number of years laid to rest depends on the usage of the land in the future.

### Issues on Land Reclamation:

Disadvantages:

Chek Jawa and Cyrene Reef

- Chek Jawa was actually planned to be reclaimed but was deferred as the government received lots of pleas from nature lovers and people to protect the one of a kind ecosystem. To destroy it would mean destroying Singapore's rich marine heritage.
- Cyrene reef is located off the mainland, near Jurong Island and is exposed when the tides are low. The reef now faces danger of further expansion of Jurong Island.

Sparking Maritime Territory Issues

- The disappearing Nipah Island, one of the 83 islands serving as a border line for Singapore and Indonesia. However, as sand is imported from all the islands, Nipah Island is almost submerged during high tides. This has caused many border disputes between Singapore and Indonesia.

Increasing Costs and at the same time keep the major shipping routes smooth.

- Tanjong Pelapas

East Coast Reclamation Scheme + Changi:

- Housing
- Schools
- The ECP (transport system-expressway)
- Was Singapore's largest reclamation site and it took 20 years to complete
- Changi Airport

Marina Bay Project:

- Marina May Sands, Gardens by the Bay, Marina Barrage, Sail@Marina Bay, Marina Bay Financial Center
- High quality housing, recreational, educational, office
- The Marina Bay Project plays an important role in the tourism industry.
- Offers High Quality living in the city area

Empoldering:

Empoldering is a way of reclaiming land from the sea and it involves the use of polders. Polders are pieces of low lying land that is maintained by drainage systems and reclaimed by building dykes to separate the sea from the land. Although empoldering is usually carried out in low-lying coastal area, it can also be carried inland such as lakes. It is usually carried in Netherlands, where most of the island is below sea level and prone to flooding.

A dike is first constructed around the area to be reclaimed to keep water away. The area is drained using pumps and drainage canals. Reed is also sown by aircraft to help the soil form. The reeds are then burnt and the ash is used as fertilizers for the soil. After a period of 15 years, the polder is ready for growing crops, building houses and constructing roads.

### Maximizing use of existing land:

#### High Density Building

With technology advances, it has enabled taller buildings to be constructed in areas where land is scarce but in high demand. These areas are considered to be high density areas because there are many people working or living per unit area. To maximize the amount of people living per unit area, HDB plans to build public housing of 30 stories or more in the more developed housing estates such as Bishan or Toa Payoh or close to the city center such as Tanjong Pagar. Pinnacle@ Duxton consists of 7 towering blocks of 50 stories each, housing a total of 1848 apartments. When higher apartments are built, it decreases the rate of the green space in Singapore to be developed. It also frees up land space for other purposes such as industries, recreational areas or water catchment areas. One disadvantage of too many people living in the small area may result in congestion and higher noise levels. This might create a stressful environment for the residents.

#### Mixed Landuse:

Mixed landuse is generally the result of landuse planning. Landuse planning is the process whereby different areas of the land are assigned to different uses. Traditionally, cities are planned according to different zones, each with different functions. People often have to travel long distance to work or to get from one zone to another. However to allow the land to meet the needs of more users, countries are starting to develop mixed landuse projects. In a mixed landuse project, there is a combination of shopping malls, housing and hotels in one area. The various landuse are normally linked by escalators or pedestrian walkways. One such example of the development is SuntecCity/ Jurong Point+ Centris/One- north @Buona Vista. As many facilities are generally located within close proximity, it can help people save travelling costs and time. It can also meet the needs of more users

#### Reclaiming Derelict Land:

##### Poor Farming Practice

Land can become derelict when there is poor farming practice. If crops are grown continuously after one another, all the nutrients in the soil would be used up and the soil become no longer suitable for the growing of crops due to lack of nutrients and fertility. Excessive ploughing of land can cause soil erosion as the soil is loosened, it become extremely prone to erosion. When this happens, nutrients are lost and the soil will become unsuitable for cultivation.

##### Mining Activities

In some cases, land can also be damaged through mining. Since the minerals are found deep underground, trees and vegetations have to be removed. Large holes are

dug in the ground and they form dangerous mining pools after rains. The mining activities might also leave heaps of mining wastes that is poisonous which can contaminate the soil.

#### How Derelict land can be reclaimed:

Derelict land can be made arable again. In the case where soil is no longer fertile, fertilizers can be added to make it fertile. In the case of mining activities, the damage to land is even greater. The mining pools needs to be filled up and the waste heaps to be removed. Chemicals is also needed to treat the contaminated soil and new vegetation and trees also needs to be planted to prevent soil erosion. The reclaimed mining land can be used for a multitude of purpose. One example is the Sunway Lagoon theme park, which was one a disused tin mine which has been restored for recreational purposes.

- Increasing demand for land, limited amount of land
- Increasing populations, growing demand for housing, industries, transport system, agricultural land and recreational areas(Delta Swimming Complex)
- Land takes up roughly 30% of the Earth's surface, yet not all is available for use
- Some land is barren and cold (Antarctica, deserts), some become derelict due to mining activities by humans or is reserved for specific purposes (military, catchment areas)
- Ways to reduce demand and problems of land constraints : **increasing the price of the land** (a one room apartment in Central Tokyo costs \$1600 a month to rent), **Reclaiming land**(Reclamation in Singapore started in 19<sup>th</sup> century), **empoldering** (Zuider Zee in Netherlands), **land clearance** (deforestation, damages the natural ecosystem; to demolish building to make land for developments, it can be costly), **reclaiming derelict land** (mining wastes heaps, pesticides and herbicides)

#### Case Study: Land reclamation in Singapore

- Marina Bay, East Coast, Tuas, Changi, Jurong Island Boat Quay

Jurong Island: more than 90 heavy industries from the world such as Shell and ExxonMobil and oil refinery factories  
Makes up 5.3% of Singapore's GDP  
Provides 8000 jobs for locals

**The amalgamation of 7 offshore islands off the coast off Singapore forms Jurong Island. It contains over 90 companies from around the world such as ExxonMobil and Shell. The corporations of the island make up 80% of Singapore's chemical and energy economy and contributed 5.3% to Singapore's GDP last year. The corporations also provide many job opportunities for the locals. The industries now provide a total of 8000 jobs. The island houses petrochemical, gas, chemicals and oil refineries industries. Without reclamation, it would be hard to have all these industries on the mainland island since they can pollute the environment and cause loud noises which might disrupt the residents. It is a quantum leap for Singapore's economy success.**

East Coast : Provides housing and schools and amenities

#### Disadvantages of Land reclamation:

Damages the bilateral relationship between Malaysia and Indonesia

**Indonesia-** Niaph Island, of the 83 Islands, which draws out the border between

Indonesia and Singapore is almost inundated with sand removed for reclamation in Singapore. This caused territorial disputes between Indonesia and Singapore.

**Malaysia-** Johor State Minister commented that fish catches decreased ever since reclamation started. Malaysia also accused Singapore government to be ignorant towards the problems they faced. Malaysia also stated that the reclamation in Singapore has diverted the shipping routes and that fewer ships are docking at the US \$1 million state of the art TanjungPelapas Port.

**Singapore**- The reclamation process has damaged Singapore rich marine heritage. Chek Jawa is an inter-tidal area located in Pulau Ubin, rich in corals and organisms faced threat of land reclamations. Cyrene Reef faces threat as Jurong Island continues its land reclamation to meet its growing demands for MNCs. Land reclamation disrupts the natural habitats and ecosystems in Singapore's waters.

Maximising use of land use:

#### Mixed Land use

Traditionally, cities were planned based on the different uses that it has been assigned to. Workers have to travel long distances to travel from their homes to their workplace and offices. To maximize the use of land space, mixed land use has been adopted. In a mixed land use project, there will be hotels, shopping malls, hotels and offices. They are linked together in a small area by escalators or pedestrian walkways. A mixed land use project allows the land to be more efficiently used. Such examples are the One North@ Buona Vista, Suntec City, The Centris in Jurong Point and Marina Bay.

Building Skywards and downwards + ammunition and remains:

With technological advancement, taller buildings and apartments are able to be built. HDB plans to build flats of 30 storeys and above in the city area, areas close to the city-area such as Tanjong Pagar or the more established housing areas such as Bishan and Toa Payoh. The city area is classified as an area of high density as many more people are living in a plot of land. With taller buildings and offices, land can be conserved for other purposes. MRT stations are also built in deeper grounds. Ammunitions are also housed underground to reduce unnecessary wastage of land (Mandai Underground Ammunition Storage). Graves are also exhumed and remains are cremated and placed in the Mandai Columbarium.

Examples:

- Pinnacle@ Duxton- Within an area of 2 hectares, there are 7 blocks of units, which houses more than 1800 units in total. Each block is 50 stories in height
- The Sail@ Marina Bay- Offers luxurious 6 star water front living. It is 250 meters in height, making it one of the tallest residential apartments in the world. Located in the prime district in Singapore.
- The Altez

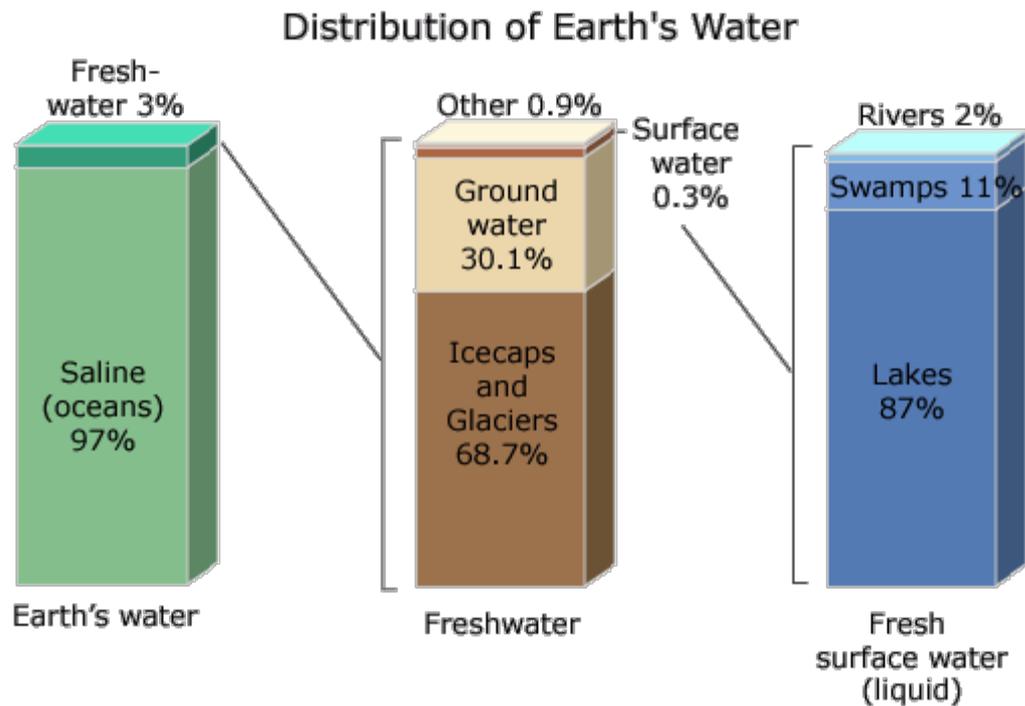
Water Constraints:

Form 3 Geography

Areas covered:

- Singapore's Land & Water Shortage
- Methods to address the problems of shortage of land and water

Water



#### Introduction

The database shows that only 3% of water on Earth is freshwater. This is a very small percentage. However, the freshwater available may not be suitable for consumption, using in agricultural and in industries. The water might be polluted. This can be due to human activities or change in climates. Human activities such as spraying pesticides on crops can result in these toxic substances being released into the water. Factories built near rivers, streams, lakes can also discharge poisonous liquids. (Ex. Lake Baikal in Russia which stores about 20% of the world's fresh water supply is heavily polluted by the discharge of chemicals by nearby factories) The change in climate can result to prolonged dry seasons in countries. Others countries might have monsoons which results to floods and deaths.

#### Rising Demand for Water

The rising demand for water has even contributed to the problem of water constraints. This is causing problems for countries with no natural resources, water scarce regions of the world.

- 1) Rising population—The world's population has increased tremendously over the years. It is expected to increase even more in the future. This means that the present amount of water is to be shared by more people and this would worsen the problem of water constraints in many countries.
- 2) Growth of Agriculture- With the increase of population, more food needs to be grown. Thus there is a need to increase the demand of water in agricultural purposes to produce more food. Large scale irrigation projects are used to channel water from lakes, rivers and from underground sources such as springs, groundwater to farming areas in countries where rainfall are scarce.
- 3) Growth of industries—The growth of industries also contributes to the problem of water contributions as water plays an important part for the function of these industries. For example water is used for cleaning and cooling machines and as

raw materials for making products such as food, chemicals and paper.

- 4) Change in lifestyle--- As a country becomes more developed, its people are able to purchase products to improve their lives. They include refrigerators and air conditioners. The rich people could also afford to build swimming pools. These increases the demand of water.

### Responses to tackle the Rising Demand for Water

If the problem of water constraint is left unchecked, many other problems can arise. It can deter industrialization rates and weaken a country's economy. It can cause a decrease in food production as agriculture will also be affected. So how do the countries in the world resolve the problem? This can be solved with the 3 steps.

#### STEP 1: Increasing the price of Water

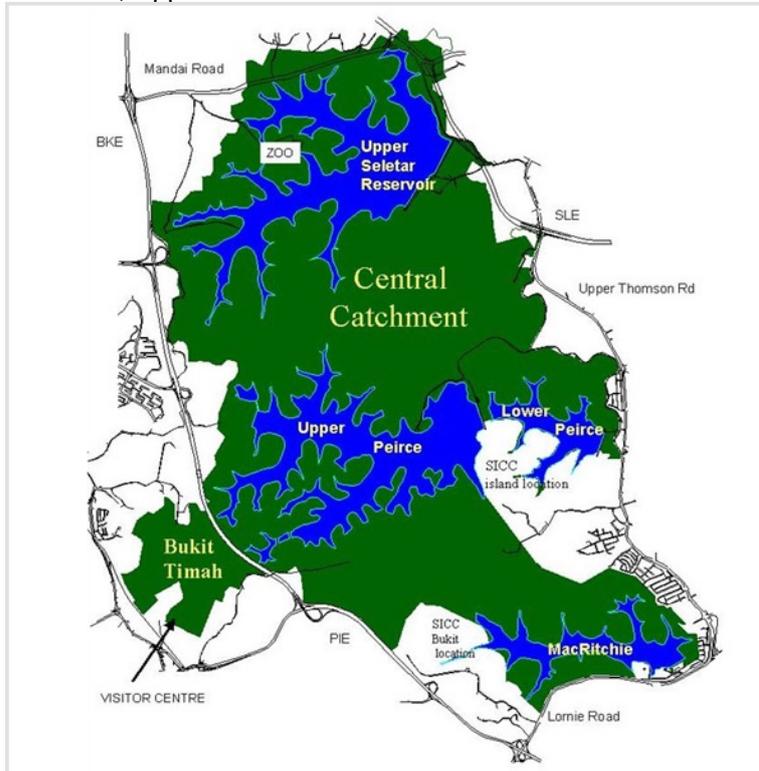
To control the rising demand for water, the country can increase the price of water. With the increase in price, people who are not willing to pay more will be encouraged to use lesser water. However, this might not be the best way to tackle the problem as only those people who are economically better are able to use the amount of water that they need. Those who are economically poorer are restrained to water use and the increase in price will only cause the poorer to suffer more.

#### STEP 2: Increasing the Supply of Water

To tackle the problem of water constraints, we can just increase the supply of water. There are 3 ways to increase the supply of water.

#### Increasing in Catchment Area

A catchment area is a place where the rainwater gets collected. An increase in the catchment area will result in more water being collected. An example of the catchment areas in Singapore is the Central Catchment Area which is made up of the 4 reservoirs; Upper Seletar Reservoir, Upper and Lower Peirce Reservoir and MacRitchie Reservoir.



Nature reserves are normally used as catchment areas as the forest helps to retain a supply of fresh water. Rain is intercepted by the plants and trees and eventually gets absorbed into the soil. The water will eventually be drained into the reservoir for storage. With the increase

of increase of the catchment areas, it not only helps to tackle the problem of water constraints but also reduces the cost of water. Since rainwater is much cleaner and requires lesser treatment procedures before it can be drunk, the cost is lesser. In addition, the nature reserves around the catchment areas provides a good place for families to appreciate nature, More forests would also be conserved and thus providing the people a wide range of nature and recreational activities. (Disadvantages: As more areas are used as catchment areas, lesser land space can be used to develop industries and build factories, building houses and public facilities. This can be a serious problem for countries such as Singapore which is facing severe land constraint. Another factor is due to the change in climate. Rain is a natural event and there may be times where lesser rain or no rains falls. In this case, the catchment areas will be ineffective to reduce water constraints. For example: Singapore receives little rainfall in the months June and July. The weather are also very dry.)

### International Agreements ( Imported Water)

Apart from increasing catchment areas, countries with water constraints can also obtain some water from neighboring countries under international agreements. An international agreement is an agreement between 2 or more countries regarding the supply and use of water resources over a specific period of time. When 2 countries sign agreements, they need to negotiate the terms and conditions on the buying and sharing of resources, (Disadvantages: These agreements do not last forever. When the agreements run out, the countries have to negotiate the terms once again. Dependence on other countries may not be the best solution as the negotiation process might not work out as planned. The countries are also uncertain about how long these resources can last)

### Use of Technology

People have used technologies to create new sources of water. Recycling water or water reclamation and water desalination are 2 examples of methods to increase the supply of water with the use of technology.

#### Recycling Water ( Water Reclamation)

Used water can be converted into portable water too! At the start of the reclamation process, used water is collected from households and factories and then channeled to water reclamation plants where impurities are removed. The end product is referred to as recycled water. The treated water from these plants can be treated further at industrial water works to produce industrial water. Industrial water is supplied to factories for purposes such as the washing and cooling of factories. With the advancement of technology, used water can now be treated further into clean drinkable water. (NEWater!)

#### Desalination

The process of removing salt from seawater is called desalination. Desalination is often used to convert seawater into portable water. It is most widely used in countries with contaminated water bodies, low rainfall and situated near the sea. There are various ways of desalination, one of which is distillation. In this process, the seawater (waste water??) is boiled and the water vapour is condensed and collected into fresh water. (Disadvantages: This method can be expensive. Under the pressure of the increasing demands in industries of natural oils and coals, the way to heat up the water can also pollute the environment!) In some parts of the world, households run their own small scale distillation plants with energy from the sun. A more recent method of purifying seawater is to use reverse osmosis. Seawater is pumped through a special membrane at high pressure which separates the water from the dissolved salts.

### THE EFFECTIVENESS

Distillation	Reverse Osmosis
Very expensive	May improve the efficiency of water reclamation
NON ENVIRONMENTAL FRIENDLY	

Although the technologies can convert used water and seawater to portable water, some people may not feel accustomed to the idea of drinking it as the minerals in the water has been removed in the process and thus giving it a different taste from the water obtained from traditional sources such as from the reservoirs. As a result, water treated are first pumped back into the reservoir before it is channeled to houses, schools and factories.

### STEP 3: Conservation 😊

Besides looking and innovating new methods to resolve the problem of water constraints, we can just do an easy step--- to conserve water. This refers to the minimal waste of water resources when we are using them. The supply of water from the catchment areas can be limited and may even run out if we do not check against our habits of using water. Water conservation helps to ensure the continuity of our water supplies so it can last longer. With water conservation, **we can help to delay the need to build more support facilities and high technology plants** to resolve the problems of water constraints. This has an advantage since the plants and facilities generally require a huge amount of land and money to build. **With the lesser development of high technology facilities, more lands can be set aside for housing, schools and building of recreational facilities.** When we practice water conservation, our **water bills also goes down.** When people in the country use less water, the government can **invest lesser money on water related facilities such as pipelines and water treatment plants.** The money can be used to invest and develop in other areas which are needed by the country. One way to encourage people to conserve water is to educate the mass public via media such as radios, television and internet. Encouraging the people may be quite a challenge as it requires the people to changes their lifestyle. Water conservation requires the cooperation from everyone and a little effort is enough to keep our water resources going! 😊

### Case Study of Singapore 😊

The problem of Singapore's water constraints is not any new problem. This is due to 2 reasons. Firstly, we are constrained by Singapore's physical environment and the uniqueness of the weather. Rivers in Singapore are not able to provide an adequate supply of water to meet our growing needs. Although Singapore has high amounts of rainfall throughout the year, there are also certain months that Singapore experience dry spells. For example: in the month June to October. With lesser rainfall, the catchment areas will not supply us with ample water. The second reason is due to the loss of lands suitable for catchment areas. Singapore's economy needs to sustain its developing economy by developing more industries and facilities. To build these, more lands has to be set aside. As a result, less land is used as catchment areas and this might worsen Singapore's problem of water constraints.

#### **Growing Demand For Water**

The growth of Singapore's population and industry increased the demand on Singapore's limited supply of water. This is expected to worsen even more as Singapore continues to develop into an international high technology research and industrial hub. These industries require a lot of water to carry out various processes. For example, the wafer fabrication park requires very clean water as tiny impurities may result in defects in the wafers manufactured. Singaporeans are also using more and more amounts of water. This is due to the change in lifestyles and the use of items that provides us with more convenience such as air-conditioners, washing machines and dishwashers. These items increase our demand in water. Singapore's population is also increasingly steadily and this will further increase the demand for water. Thus, we can see that water plays an important part. Without water, we cannot survive and industries will not be able to flourish. We need to manage our supply of water more carefully.

### **Singapore's 4 National Taps !**

#### Tap 1: Catchment Areas

Water from local catchment areas is stored in reservoirs and storm water collection pools. Before 1975, there were only 3 reservoirs in Singapore. They were mainly MacRitchie, Lower Pierce and Upper Seletar. 11 more reservoirs were constructed over the years to meet our increasing water needs. The reservoirs were created either by building dams across rivers or

along the coastlines. In addition, storm water pools have also been constructed in some housing estates. The ponds collect storm water and channel the waters to the reservoirs. It is expected that by 2009, Singapore's water catchment area will increase 1/2 to 2/3 of the island.

### Tap 2: Imported Water

Another way of increasing our water supply is to buy water from other neighbouring countries. Singapore has been buying waters from the Malaysian State of Johor since the 1920s. At present, there are 2 water agreements signed with the Johor Government, of which expires in 2011 and 2061 respectively. However, getting water from other countries might not be such a good idea after all. When the agreements expire, the country can choose to not continue to supply water to Singapore. Hence in the long run, it would be better for Singapore to be self-sufficient and obtain water from local sources.

### Tap 3: NEWater

Water reclamation is another method for Singapore to increase its water supply. With the advancement of membrane technology, used water are able to be treated and produce a very high grade of water known as NEWater. NEWater has surpassed international drinking water standards and is supplied to industries such as wafer fabrication parks, which requires very clean water to clean the wafers. Any trace of minerals would defect the wafers. However, NEWater is not pumped directly to houses as Singaporeans are used to drinking tap waters from the reservoirs. NEWater is too clean and has no minerals which are essential for life and it tastes different. As a result, only a small amount of NEWater is added to the reservoirs first before it is sent for treatment at the water works and channeled to homes.

### Tap 4: Desalination

Singapore also used desalination to increase our water supply. A desalination plant was started in Tuas in 2005. Although the cost of operating the plant was high, it will supply up to about 10% of the country's supply of water. The plants uses reverse osmosis.

Increasing the price of water is one way to reduce the total consumption of water. If a person doesn't want to pay a huge bill, then he will consider using lesser water. However, when we increase the price of water, it creates a social barrier between the rich and the poor. The rich can use as much water as they like while the poor suffers. Increasing the price of water can help to cut down water usage but it seems to have a huge impact on those who are less economic-able.

Another way to tackle the problem of water constraints is to increase the catchment areas. When rain falls on catchment areas, they are being channeled to different reservoirs. An increase in catchment area would mean more water being collected during a rainfall. One catchment area in Singapore is the Central Catchment Area. Reservoir is generally surrounded by forests and nature reserves. When rain falls, the soil can retain the water. The water is then intercepted by plants and trees and eventually gets stored inside the reservoir. Water catchment areas also keep the costs of water low since rainwater is much easier to purify than waste water and seawater. With increasing catchment areas, people will get to enjoy a wide array of recreational sites. It would also become a good educational site. One example is the MacRitchie Reservoir in the Central Catchment Area. The nature reserve provides good recreational areas and there are also exhibitions on the Singapore's oldest reservoir. Having more catchment areas also slows down the rate of green space being lost. It also protects Singapore rich wildlife heritage.

However, with more water catchment areas, there will be no land for other developments, especially when water catchment areas already take up 3/4 of Singapore's land area. Although having more reservoirs means that more water can be collected, during times of dry season, the reservoirs have no effect at all.

## International Agreements

One of the 4 national taps for Singapore is importing water from Malaysia, Johor. Singapore has signed 2 water agreements with Malaysia, one which ends in 2011 and the other in 2061. Although the agreement signed with Malaysia is an extra source of water for Singapore, the agreements do not last forever. When the agreement expires, Singapore would need to negotiate with Malaysia and the process might not go according to as planned. Malaysia also might not know how long their supply of water can last for their people. If there is not enough water, Malaysia might stop supplying us with water. So Singapore has to develop its own ways of supplying itself water.

Waste water can also be recycled. Waste water from factories, homes are channeled to NEWater plants to be cleaned. With high membrane technology, the used water can be turned into portable water.

Water Availability on Earth:

Seawater- 97%

Freshwater- (Ice, snow and glaciers: 2%, Aquifers, surface water: 1%)

Reasons for water constraints: **increasing populations, change in lifestyle** (increasing quality of lifestyle: dishwashers, air-conditioner), **increasing demand in agriculture** (increasing populations require more plantations and harvest, large irrigation projects to dry land for agriculture), **increasing numbers of industries, uneven distribution of rainfall** (Canada and India: Canada has 20% of the world's fresh water supply while India has 10% yet India's pollution is 30 times that of Canada's), **pollution of water sources** (Lake Baikal in Russia, world's largest fresh water lake, is polluted with chemicals from nearby factories).

Ways to tackle the problems of water constraints:

### 1) Water Catchment Areas:

- Singapore's Central Catchment Area: MacRitchie, Upper and Lower Peirce, Upper Seletar Reserve
- Nature Reserves mostly surround the catchment areas, as the soil can retain the rainwater and will flow into the reservoir
- With more catchment areas, more greenery will be preserved, it also serves as a recreational area
- Helps to lower the price of freshwater since rainwater is easier to purify compared than seawater and other water.
- However, by increasing the number of catchment areas doesn't mean that more water will be stored; it is dependent on the climate. Singapore experiences months of dry spell during June, July.
- With more catchment areas, lesser land will be available for industries. The problem will be exacerbated in countries with land constraints such as Singapore.

### 2) International Agreements:

- Singapore and Malaysia's water agreements will end in 2011 and 2061
- Signing international agreements is an easy way to obtain water, but countries cannot place too much dependence on it
- However, agreements do not last forever and countries need to negotiate for terms and it might not be a success
- Countries do not know how long the water supply can last for both countries and the country selling water might run out of water and decide to stop selling water
- India and Bangladesh's water agreement in 1966 is valid for 30 years and is reviewed by both governments every 5 years

### 3) Recycling Water/NEWater

- Water from the

### 4) Desalination

Land pollution occurs due to the following reasons: Improper disposal of sewage, waste over mining heaps and use of herbicides and pesticides in agriculture. It can lead to health problems and environmental problems. As the populations continue to increase, more wastes are produced. Wastes can also be produced from industries, which over the decade had increased tremendously and pay a huge part of environmental pollution. With the lack of land faced in many countries, lesser land is available for landfills. These wastes are either placed in illegal dumping grounds or simply left in the public areas where they store stagnant water and become massive breeding grounds for germs and insects. Mining operations can also leave unwanted heaps of mining wastes which can be very dangerous and can contaminate the soil. Large amounts of vegetations are also removed to dig holes for the precious ores. Deep mining pools are also formed and can pose hazard. In agriculture, increasing numbers of pesticides and herbicides are used to increase yield to meet the ever-growing demand for food. The pesticides and herbicides can keep away pests and weeds which can damage the crops and cause a reduction in harvest. However, as time passes, these pests will become immune to the existing pesticides. The farmers would either increase the dosage of pesticides used or simply devise a new one. These chemicals can seep into the ground and even contaminate water-table. Both of them which can exacerbate the problems of land pollutions. When the wastes are not disposed of properly, it can affect the health of humans. Bacteria and insects will be breeding in the wastes and can cause illness. The crops might also take in the pesticides and herbicides. When human consume them, they may accumulate and cause cancer. Land pollution can also cause serious environmental problems. The pesticides not only effects harmful pests but also useful organisms such as earthworms. The earthworms might be eaten by the birds and the poison, passed on and accumulated to them. The harmful substances can be accumulated and moved up into the food chains. This is known as bio-accumulation and can cripple the delicate balance of food webs and even damage the reproductive systems of some animals and thus affecting their numbers.

Water pollution is caused by the improper disposal of sewage and by oil spills. Oil spills occurs when large oil tankers collide into one another or when oil tankers brushes across sharp rocks, and breaking the containment vessel. The oil that is stored would flow out and then spread, Oil spills are hard to clean up because they are not easy to degrade and tend to spread on the sea very quickly, covering vast areas of the region. Another reasons is the improper disposal of sewage. Sewage can exist as solid and liquid and can come from the industries and households. When these sewages are released into the water sources, it can cause a lot of damage. In industries, sewage in the manufacturing stage contains many heavy chemicals. Most are discharged into the nearby rivers or seas for convenient sake, causing heavy pollution to occur. Some countries treat the sewage first, before releasing the treated sewage into the water bodies. However, some substances might still be present in the treated sewage. These substances might be non-biodegradable and might stay in the water source for a very long time and continue to cause water pollution. Oil spills can sewage can casue extremely vast and destructive impacts to the environment. When birds and mammals get in contact with the oil floating on the water, their furs, which acts as insulators, will be stuck and become hard. These prevents the animals from keeping afloat or fly. Most animals will either starve to death unless the oil are cleared from their furs. Also when household sewage enters the water source, it can contain chemicals that might cause damage. The chemicals in detergents, for example can cause algae bloom on the surfaces of water. This blocks out the sunlight for underwater plants. Those organisms dependent on these plants would also die since the plants are not able to photosynthesis and would die. The oxygen content would also run long and all organisms would perish. When these chemicals are discharged into the seas and rivers, fishes and shellfish might take in these substances. When humans consume them, the harmful substances will pass on to humans, inflicting diseases such as cholera and typhus. One example would be the Minamata Bay incident in Japan. Water pollutions can also cause impact to the economy. When the harmful substances seep into water sources, the fishery industry might be affected. The livelihood of fishermen might be effected. Also oil spills can be washed ashore, reducing the quality of the seawater. This can affect the tourism industry in that country as tourists would not want to go anymore. Oil spills and swages are also very hard to clean up and require a lot of money. Take the Exxon Valdez spill for example, it took the US government 4 years to clean up, involving 10,000 workers and US \$2.1 billion.

Air pollution can be caused by humans or can be a natural occurrence. In 1991, Mount Pinatubo in Philippines blew its top. The ash plume rose to a maximum height of 37 km and covered most of V Central Luzon in ash and blotted out the Sun in the region for a few days. During volcanic eruptions, large amounts of ashes, dust and gases are released into the atmosphere and can cause air pollution in the region depending on the scale of the eruption. Another naturally occurring phenomenon is forest fires. When weather is dry coupled with high temperatures, it increases the risk of vegetation setting fire. When vegetations burn, large amounts of dust and smoke with carbon dioxide is released into the air. These dust particles can be carried to other countries by wind. Industries and power plants can produce a lot of carbon dioxide and soot. When power plants burn fossil fuels to produce electricity, the carbon dioxide in the fuels are released. With increasing demand in electricity, the industries have a huge part to play in the contribution towards air pollution. Motor vehicles also give out gases such as carbon monoxide. In urban areas, 90% of the smoke particles come from the vehicles and has become one of the most serious problems in cities. Construction work, land clearance and transport of construction materials can also produce dust and smoke which can be carried by the wind to the residential areas nearby. Haze is an annual occurrence in Singapore but it was extremely bad in the 1997. Forest fires in Indonesia coupled with wind currents blew the smoke and dust particles to Singapore, Malaysia and Brunei. Hazy skies were recorded in any parts of Southeast Asia. The air pollution can be a source of traffic hazard. When there is haze or smog in a country, visibility decreases. Airports have to be closed down or some flights have to be cancelled in fear of accidents till the visibility improves. The haze can also be a source of trouble and danger for drivers on roads. Air pollution can also cause impacts to the environment. In areas with a lot of heavy industries, the gases and smoke released blends with the water vapour and falls as acid rain. The acid rain can cause massive damage to local buildings and architecture. When the rain falls into or gets washed into water sources, it can kill the organisms with its low pH. Lastly, the smoke and haze can also be a hazard for human health. It can cause diseases such as asthma and bronchitis. The gases such as carbon monoxide, which is released from vehicles can even cause death. Sulphur dioxide can attack a person's respiratory system and increase the chance of developing heart and lung diseases and even lung cancer. Lastly, a study show that a person who is constantly under environment with air pollution will have a shorter lifespan of about 1-2 years as compared to a healthy person.