# SaRASS Prototype

(Simple Water Absorption Facility)

The conservation and preservation of soil water from the rainfall outflow

## BACKGROUND

"Saras" or "Laras" in ancient Java means the ideal condition. In the field of conservation, water is included in soil water. The expected ideal condition of this is that the water will not reduce in quantity and the soil water quality is preserved. Therefore, the use of the well for water absorption is considered important in order to refill the soil water. Concerning this case, there are some local governments urging the construction of the absorption well related to the IMB (the permit to construct a building). However, because of the surface water outflow, the rainwater passing through the absorption well will dissolve the polluted substances having a potential to pollute the soil water. Therefore, the existence of a technology which can perform the groundwater recharge for soil water conservation and free from pollution is required.

## GOALS AND OBJECTIVES

This research is aimed at finding the substances which can absorb the polluted substances dissolved by the rainwater outflow. The substance must be easily found and obtained in the market. The substance will be integrated to the existing absorption well technology. Therefore, the simple technology for water absorption well to refill the soil water is achieved and the soil water quality is maintained.

THE ANALYSIS RESULT OF ZEOLIT FILTRATION

| no | parameter | unit | Identification result | | |
|---|---|---|---|---|---|
| | | | before | after | |
| | Physics | | | | |
| | Muddiness | | | | |
| | Color | | | | |
| | DHL? | | | | |
| | TDS? | | | | |
| | TSS? | | | | |
| | chemical | | | | |
| | pH | | | | |
| | Hardness of water | | | | |
| | Fe | | | | |
| | Mn | | | | |
| | cuprum | | | | |
| | zinc | | | | |
| | chrome | | | | |
| | cadmium | | | | |
| | Pb | | | | |
| | Fluoride | | | | |
| | chloride | | | | |
| | Sulfate | | | | |
| | Nitrate | | | | |
| | Nitrite | | | | |
| | Active | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | compound Birumetilen | | | | |
| | phenol | | | | |
| | Fat | | | | |
| | Phosphate | | | | |
| | ??? | | | | |

Information:
*= before the test in the laboratory
**= after the test in the laboratory
***= PERMENKES No. 416/MENKES/PER/IX/1990

SaRASS construction scheme ; concrete-made gate, metal lifter, zeolithe, gutter pipe with filtration, concrete, pebble, absorption hole,

THE LABORATORY TRIAL
The laboratory trial for the use of zeolit as the absorbing tool of polluted substances
The estimation of SaRASS construction cost (in August 2007)

| explanation | Individual type (< 150 $m^2$) | Collective type (150 – 400 $m^2$) |
|---|---|---|
| 1. Concrete | | |
| 2. Filler:<br>Pebble<br>Zeolithe | | |
| 3. Gate | | |
| 4. Cement floor | | |
| 5. power | | |
| total | | |

The installation of concrete
The arrangement of inlet and outlet pipe
The installation of inlet and outlet pipe
The installation of gravel and zeolit

CONCLUSIONS

1. The laboratory trial shows that Zeolit is able to reduce the polluted substances overflowed by gutter water and rainwater.
2. SaRASS prototype has a function to conserve the soil water and also to reduce the risk of the occurrence of the accumulation of soil water pollution caused by rainwater overflow.
3. This prototype can be installed easily and quickly. Besides that, this prototype can be conducted individually or collectively by low expense. The total expense for creating the individual type is about Rp 350.000,- while the collective type is about Rp 1.150.000,- (for the construction site in Bandung in 2007).

TOLOOONG!

HELLLLLLPPPPP!!
Don't disturb water absorption and don't take too much groundwater
Take a look….!
The surface water level is getting increased while the water table level is getting decreased.

WHY DOES IT OCCUR…?

1. Water of the earth experiences the hydrological cycle and forms a dynamical equilibrium;
2. Half of the precipitation becomes the surface water and half of it is absorbed and forms the groundwater
3. Any disturbance to hydrological cycle component, naturally, will lead to the formation of new equilibrium
4. The occurrence of flood and the decrease of groundwater level is the result of the new equilibrium

WHERE DOES THE DISTURBANCE OCCUR…?

1. In the absorption area, there occurs the changing function of land which will accelerate the surface current
2. In the groundwater pumped area, there occurs the water pumping exceeding the amount of aquifer supply

WHO HAS TO BE RESPONSIBLE OF IT…?

1. Each and every land owner or user must manage their own land to optimize the absorption area
2. Each and every groundwater user must fill some water into the aquifer with the same amount of the used water in the form of the artificial absorption area.

ARTIFICIAL ABSORPTION AREA FUNCTIONS AS AN ENVIRONMENT BASED DRAINAGE

1. Substituting the natural absorption
2. Adding the groundwater reserve
3. Increasing the surface water table
4. Creating the freshwater for groundwater in the seashore or in the small island
5. Preventing the infiltration rate of brine in the seashore
6. Decreasing the surface current

THE FORM OF ARTIFICIAL ABSORPTION

A. For the free charging groundwater
    1. A well with 0,8 – 1,0 m in diameter is better drilled up to surface water table;
    2. A well drilled in ground, with the holed casing, is better drilled up to the surface water table;
    3. Absorption Trench;
    4. Drainage with porous cell;
    5. Water releasing prevention;
    6. Pond, *embung*, lake, retention dam;
    7. The managing of farming area with a conservation concept by making porch, *gulud, rorak* or any other thing which can block the surface current

B. For the restrained groundwater
    1. The drilled well with $4^n$-$6^n$ with the depth reaching the aquifer which is in accordance with the water consumption

REQUIREMENTS
1. The absorbed water at least has the same quality as that of the ground water
2. It is not placed in the dangerous slope
3. It is not placed in an area full of waste

USED SITE
1. The artificial groundwater absorption is made shallow, especially in the absorption area
2. The deep artificial groundwater absorption is applied in village, especially the village having the decrease of surface water table.

Lock (Penutup)
Inlet Pipe (pipa inlet)
Spillway pipe (pipa pelimpah)
Brick wall (dinding bata)
Pebble (batu kerikil)

WITH ITS OWN WAY, NATURE WILL TAKE AN AVENGE ON EVERY DISTURBANCE HUMAN CONDUCT

BENDUNGAN BAWAH TANAH

UNDERGROUND DAM

As a water storage alternative in arid areas and small islands
The basic study for supporting the realization of underground dam in Bunutan – Bali
The alternative technology of water supply for arid areas

WHAT IS THE MAIN PROBLEM?
Generally, Indonesia is a tropical country having two seasons, rainy season and dry season. Each season occurs for six months. Therefore, Indonesia is not supposed to experience the water shortage in dry season.
However, the fact shows the opposite. Many areas in the center and east Indonesia experience the water shortage, especially the areas in small islands.
It is not uncommon to find some people in certain areas who have to walk far away to get water or to find those who cannot take a bath everyday in dry season.

WHY IS THERE NO WATER SUPPLY?
There are some factors causing the water shortage in some areas as follows:

- The low amount of rainfall;
- The geological condition in which there is the permeable rocks which make the water dissipate deep down below the surface or the impermeable rocks which make the water cannot dissipate into the rocks and become the surface water only and directly flows to the sea;
- No stabile surface water flow
- The impossibility of building the conventional dam or water storage site because of some other factors;
- No high mountain to condense the water

A WAY TO HANDLE THE ABOVE CONDITION
Another alternative to handle the water shortage is by building the underground dam.

WHAT IS THE UNDERGROUND DAM?
The underground dam is a water storage construction built underground. It is aimed at trapping the absorbed rainfall and making it the groundwater or the surface water and keeping the water to be used if there is no rain or the surface water. This matter is expected to fulfill the society needs of water, for supporting their household activities, farming activities or tourism activities.

Gambar 1
Farming area (lahan pertanian)
Rain
Sea
Impermeable layer (lapisan kedap)
The geological and environmental condition in which the underground dam can be constructed

Gambar 2
Idem
If the underground dam has been constructed

The underground dam construction is chiefly waterworks;

- It is environmental friendly / do not change the landscape;
- It is not necessary for area exemption or people transfer;
- It enriches the soil water in the area;
- It helps the reforestation of arid areas;
- It is not dangerous if there are some damaged caused by earthquake / it is compatible for those areas having the higher occurrence of earthquake;
- It protects the area from the occurrence of sea water intrusion;
- In the area above the underground dam reservoir, the activities conducted before the dam is constructed can still be conducted.

IS THERE ANY UNDERGROUND DAM IN INDONESIA?

There is not any underground dam in Indonesia. Therefore, *Pusat Penelitian dan Pengembangan Sumber Daya Air* in Bandung starts to realize the existence of underground dam in Indonesia. This thing is conducted by doing a study and an experiment looking for the alternative sites for constructing the underground dam. The sites having been studied before are Bunutan, Bali and Sikumana, Kupang NTT.

Gambar 3
The drilling process, one process in observing the underground dam

Gambar 4
The diagram concept from underground dam

WHY ARE THE TWO SITES CHOSEN?

The reasons of the using of those two sites are as follows:

- Bunutan, Bali has a specific geological condition for underground dam with the type of alluvial reservoir
- Sikumana-Kupan, Nusa Tenggara Timur has a limestone reservoir geological condition by using the existing underground stream of the area.

WHAT KIND OF STRATEGIES ARE PREPARED FOR CREATING THE UNDERGROUND DAM?

Up to now, Puslitbang Sumber Daya Air and Japanese Green Resources Corporation have conducted some research activities and also have started doing experiment in detail for the underground dam site in Bunutan, Bali. The achieved experience can be used as the model to build the other underground dams in some other places in the future.

Gambar 5
The underground dam site in Sukamana, Kupang, NTT
Reservoir type = limestone

Gamnbar 6
The underground dam site in Bunutan, Bali
Reservoir type = alluvial

APA YANG SEHARUSNYA DILAKUKAN SAAT BANJIR

What should be done when flooding

1. Listening to the radio and announcements about flooding in your area
2. Turn off electricity
3. Move valuables and medicines to the high place
4. Move the transportations to high ground outside the house
5. Move the substances or liquid that can pollute water
6. Do not cross the floodwaters if still can be avoided
7. Do not walk alone in the flood inundation
8. Priority of children and the elderly if we have to evacuate
9. Lock the door if leaving home
10. Aids flood prevention efforts in mutual cooperation
11. Report the important flood events to the authorized officer
12. After the floods recede together to clean the house and yard

Contact us if you need the appropriate technology or strategic:

- Beach safety
- Simple weir
- Waterwheel
- Saw sprawler
- Corrosion-resistant automatic sluice
- Peat water treatment plant
- A very simple water treatment installation
- Embung as a water provider
- Integrated water resources management
- Microhydro for electricity and water pumps
- Technical recommendations in the form of supervision in the field of water resources
- Technical recommendations for artificial recharge of wells
- The potential study for underground reservor

EKOTEKNOLOGI PADA BADAN AIR UNTUK MENGURANGI BEBAN PENCEMARAN
Wetland in Water Sources to Reduce the Pollution

Description

The polluted surface water is getting increased gradually from year to year caused by the increase of pollution from industrial, farming, and animal husbandry activities and by the increasing amount of inhabitants. The improper facilities for pollution prevention just make the problems get worse. The effect of this condition is that the water source is polluted seriously because it contains water having the high level of BOD, COD, N&P, and excrement coli and having the lower level of dissolved oxygen. This condition must not be put aside. An action to process the waste water before being wasted to the water source must be conducted.

Up to now, a lot of processing techniques have been conducted to reduce the polluted substances, such as the processing system conducted Physically, Chemically, and Biologically or their combination. However, this technology requires higher operational and maintenance cost. One of the simple technology alternatives with lower operational and maintenance cost is by employing ecotechnology or known as Wetland

Technology Function

To absorb polluted substances (BOD, COD, Detergent, SS) from water waste by employing the plants.

The mechanism of polluted substance absorption by water plantation
Filtration and Absorption of N,P by root
Filtration by Denitrification and absorption
Contact effectivity by trunk

The absorbing processes of polluted substances in Waste Water Processing System by employing Wetland are as follows:

- The level of BOD of waste water is reduced through oxidation and reduction (aerobic fermentation)
- Ammonium ($NH_4N$) is oxidized by autotrophic bacteria in rhizosphere into nitrate and then into nitrite. Finally in anaerobic state, it will be changed by anaerobic facultative bacteria into $N_2$ gas.
- Phosphate is tied by Fe, Ca and Al of the soil in anaerobic state. The oxidation in rhizosphere area could reduce the plant poisoned caused by $H_2S$ and it also could reduce the level of Fe and Mn of the waste.

Strengths

- the operational and maintenance cost is cheaper because it does not need mechanical and electrical devices
- it does not need any expert

- the processing efficiency by plantation could absorb polluted substances, especially BOD, COD, Ammonium, P-total, Nitrate and Bacteria

| The specimen plantation in wetland | The processing efficiency, parameter: | | | | |
|---|---|---|---|---|---|
| | TTS | BOD | COD | Amonium | P-Total |
| Tyipa sp. | | | | | |
| Thalia dealbata | | | | | |
| Pontederia cordata | | | | | |
| Cyperus alternifolius | | | | | |

*the location is in domestic IPAL, Bojongsoang

Technique Specification

- Land works (excavation and filling) include the merged pipes, manholes, wetland pool and controlling pool without plantations.
- Civil works (foundation, concrete, compound, cement) include:
- Manholes with length x width x depth = 0.6 x 0.6 x 1.0 m
- Equalization case with length x width x depth = 7.5 x 2.0 x 2.5 m
- The debit measuring device *Thomson V notch type* ; material: metal with 5mm thickness, channel width = 1m, and two aerations Cascade type with length x width x height = 0.9 x 1.0 x 0.2 m.
- One wetland controlling pool (without plantation) and four wetland pools (with plantation), each with length x width x depth = 15.0 x 6.0 x 0.85 m and one monitoring pool with length x width x depth = 1 x 1 x 1 m
- Mechanical works include:
- Automatic floodgate with length x width x height = 1.0 x 0.8 x 0.05 m
- 21 bar-screens consist of 6 mm in diameter metal and $60^0$ deviation
- The pipe works and its equipments consist of merged pipes, manholes and pipe between processing unit
- The works of plantation media consist of coral, Lembang soil, and wetland plantations such as Thypa sp., Cyperus alternifolus, Pontederia cordata, and Thalia dealbata.

The Diagram of Field Scale Wetland Channel
The merged water waste channel
Equalization case
Distribution channel

a. Floodgate
b. Screen bar

c. Debit measuring device
d. Aeration
e. Wetland pool (with plantation)
f. Wetland pool (without plantation)
g. Manhole

Equalization case
Screen bar
Floodgate
Debit measuring device

Equalization case and distribution channel

Typha sp
Thalia dealbata
Cyperus alternifollus
Pontederia cordata

Prototype applied site
The wetland prototype site is located in Green Belt Saguling Dam, Cangkorah Village, Batujajar sub district, Bandung Residence
The wetland prototype can be applied in the other water sources (lakes, rivers and general channels)

Operation and Maintenance
1. Check all pipe systems, including inlet faucet in each pool, that are in pools containing: Thypa sp., Cyperus alternifollus, Pontederia cordata, Thalia dealbata, and the controlling pools without plantation
2. Set the processing debit in each pool for about 0.01 L/s
3. Observe the plantation growth during the prototype operation. If there are some unwell or damaged plants found caused by pest, the plants must be immediately replaced by new plants.
4. Do the periodical harvesting based on the population density of each plant. The harvesting is conducted by pulling out 2-3 rows of plants (± 1.5 m) and they are replaced by younger plants existing in each pool. The following harvesting activity is conducted by pulling out of 2-3 rows of the plants that have never been harvested before.
5. Some of the plant harvesting crops can be used as the seeds and the other can be sold (for example, Thypa sp., Cyperus alternifollus and Thalia dealbata,)

PENERAPAN PIPA BETON SILINDER DALAM USAHA PENGAMANAN PANTAI
The Installment of cylinder concrete pipe for security along the seashore

Preface

The use of cylinder concrete pipe as the seashore security construction unit is aimed to introduce the practicable construction which does not need to use heavy tools and can be conducted by local inhabitants. Besides its practicability, the realization of seashore security construction by pipes will be finished in shorter time. These matters are very beneficial for the works conducted along the sea which will be affected by the rise and the fall of the tide in which at certain condition, people there can only work when the tidewater recedes. However, the use of the water is limited to shallow waters in which when the tidewater recedes, people still can work and pour concrete as the unit fillers.

The used pipe units are in the form of cylinder. Besides its easiness to be lifted, the round pipes are easily found in market. To place the pipes in their appropriate position, especially for those placed in the bottom, the sea bottom drilling is required.

For the uncovered sea security construction, it is suggested to use concrete mixture with the ratio of 1:2:3 because the pipes will get hit by breakers carried along the sand. The low quality concrete will be abraded easily.

GBR1. The crib construction

Most of the sea security construction built before cannot resist tensile strength. Therefore, the concrete pipe units do not need to have the frame. However, the lifting of them needs to be conducted carefully since they have no frame which makes them more fragile. The detriment of giving the frame to concrete pipe is that if the concrete installation is not conducted well, probably the concrete will be easily affected by seawater and corrosion. The corrosion occurred in the frame will weaken the pipe units.

The filling substances can be pumice or light mixture of concrete. For pumice as the filling substance, the installation must be conducted carefully by filling exactly all holes. The arrangement can be conducted in line or in pile. For the units arranged in line, the armatures are installed through the special hole made in the pipes. For the units arranged in pile, the armatures are installed in the merged part.

The applied site

The sea security made from round concrete pipe has been constructed in some seashores of Bengkulu, Tanjung Pasir, Pangandaran (West Java), Kedung Semat (Semarang), Tuban (East Java), Kuta 2 and Nusa Dua (Bali), Senggigi (Lombok) and Manado. In the overleaf, there is a short explanation concerning the four types of sea security constructed in Tanjung Pasir and Pangandaran (West Java), Tanjung Benoa and Nusa Dua Bali.

1. Pangandaran Seashore
   The prevention of the occurrence of erosion in the east of Bukit Pananjung, Pangandaran has been performed by constructing the seashore security construction which is the 1500 m sea wall. The 700 m of the sea wall consists of pumice compounds made in 1989 while the other 800 m of the sea wall consists of concrete pipes made in 1992 and 1993. The diameter of the pipe units

used is 0.8, and its height is 0.5 m and is arranged in piles. To prevent the erosion in the embankment caused by the wave, the protection made of pumice is constructed. In Picture 1, you can see the construction vertically and in Picture 2 you can see Pangandaran's sea wall condition.

Picture 2. The sea wall condition in 1994

GBR1. The vertical picture of the construction

2. Tanjung Pasir Seashore

   To prevent the erosion in Tanjung Pasir seashore, the installation of embankment has been conducted with 70 m in length, 5 cribs with 50 m in length each installed 15' at an angel to the normal sea latitude and embankment protector with 300 m in length. The crib consists of concrete pipe units with 0.8 mm in diameter and 0.5 m in height and is arranged in piles while the embankment protector consists of pipe units with 0.6 m in diameter and 0.5 m in height and is arranged in lines. The height difference between the ordered two pipes in the embankment protector is about 0.25 m. In picture 2, you can see the construction vertically and in photograph 3, you can see the condition of embankment protector in 1993.

   Foto 3. The embankment protector condition in 1993

   Gbr2. The construction seen vertically

   Dwellings

   Drainage

   Concrete pipe filled by light concrete mixture

   Plastic bag filled by sand

3. Nusa Dua Seashore

   In securing the seashore in Nusa Dua, in 1986, 1987 and 1988, 4 upright cribs have been made with each 125, 110, 100 and 90 m in length. A crib paralleled with the sea is 225 m in length and a U shaped crib for covering the stream is 120 m in length. Those cribs consist of concrete pipe piles with 0.5 nm in height and with 1.0 m in diameter. They are constructed above the hard coral reef with maximum water depth of 2m when the water is high and with no water when the water recedes.

   To give the natural view, some cribs are covered by limestone with 30 cm thickness. In Picture 3, you can see the vertical picture of the construction and in photograph 4, you can see the covered crib condition in Nusa Dua seashore while in Picture 4, you can see the vertical picture of the construction and in photograph 5, you can see the uncovered crib condition.

Picture 4. Crib condition in 1987

Photograph 3. The vertical picture of the construction

Picture 5. The crib condition in 1987, see the sand sedimentation in the right side held by the crib

Photograph 4. The picture seen vertically

PENGOLAHAN AIR SELOKAN (GREY WATER) DALAM BENTUK ECOTECH GARDEN
Grey water's processing into ecotech garden

WHAT IS GREY WATER?
Grey water is clean waste water from baths, kitchen and sinks (washing machines).
GBR1. Almost all dwellings in Indonesia throw grey water directly into gutter without being processed first. Black water (human's excrement) from water closet is usually processed in septic tank.

WHY DOES IT HAVE TO BE ECOTECH GARDEN?
Because there occurs the decomposition of organic substances (biochemical reaction) which needs the dissolved oxygen in which it could reduce the dissolved oxygen content in waste water. It is marked by black, foamed, and stunk waste water. The reaction occurs:

$C_xH_yO_2N_2S_2 + H_2O \rightarrow NH_4 + CO_2 + CH_4 + H_2S + 368$ kal/gr/protein

Protein ammonia stink

HOW IS ECOTECH GARDEN?
Ecotech garden is one technology alternative to process grey water or effluent septic tank by employing water plants.
N & P are absorbed by plants to grow. They could also reduce the polluted substance; BOD, COD, Detergent, pathogen bacteria (effluent septic tank), and also lessen the unpleasant smell and also clean the water.

THE MECHANISM OF POLLUTED SUBSTANCE ABSORPTION IN ECOTECH GARDEN
GBR2. Grey Water (BOD, COD, MBAS, SS, Bacteria, Total-N, Total-P)
The absorption of polluted substance by root (BOD, COD, Detergent, SS, Bacteria, etc)
The absorption of T-N and T-P elements which function for growing
It increases rhizosphere (plant roots). It increases microorganism for ± 10-100 times because there is the distribution of oxygen from leaves. This helps the absorption of polluted substances from the processed waste water.
The processes of polluted substance absorption;

- The waste water of BOD is reduced through oxidation and reduction processes (aerobic fermentation)
- Ammonium ($NH_4N$) is oxidized by autotrophic bacteria in rhizosphere into nitrate and then into nitrite. Finally in anaerobic state, it will be changed by anaerobic facultative bacteria into $N_2$ gas.
- Phosphate is tied by Fe, Ca and Al of the soil in anaerobic state. The oxidation in rhizosphere area could reduce the plant poisoned caused by $H_2S$ and it also could reduce the level of Fe and Mn of the waste.

ECOTECH GARDEN IN BUMI ASRI PADASUKA RESIDENCE

It is made in 2005, by employing the open grey water channeled into the house's garden. It is made U-shape (surface width 2.06 $m^2$, debit 0.07 L/second). The aim of Ecotech Garden construction is to recycle the grey water and also to create a decoration in the form of decorative plants in the garden.

(a) The open gutter of grey water
(b) The inlet of ecotech garden
(c) The outlet of ecotech garden

The scheme of Ecotech Garden as the Grey Water Processor

Pontederia Cordata
Water Cana
Arrowhead Sagita Japonica
Waterdrop-Echinodorus paleafollus
Water Cana
Cyperus papyrus
Typha angustifolla

The effectivity of Ecotech Garden or The decrease of polluted substance

The graphic effectivity of Ecotech Garden to process the grey water

The factors influencing the Ecotech Garden effectivity:

- The processing debit, the smaller the same expanding processing debit is, the higher the decrease of polluted substance will be
- The contact time, the smaller the contact time is, the lower the reduction percentage of polluted substance will be.
- Hydraulic loading, the higher it is, the lower the reduction percentage of polluted substance will be. Hydraulic loading Ecotech Garden = $3M^3/day/M^2$ (It is too high because the design criteria in US EPA, 1988: 0.014 – 0.047 $M^3/day/M^2$ ), or 60-215 times than the US, EPA 1988 criteria.

The effectivity development of Ecotech Garden

- Reduce the debit. It is controlled by the simple floodgate.
- Expand the surface area so that the Contact Time and Hydraulic Loading are fulfilled and the reduction percentage of polluted substance gets increased. The increase of N & P absorption also occurs in which it causes the increase of the frequency of the permanent management of new plants.

The construction cost of Ecotech Garden

The construction cost of Ecotech Garden is Rp 300.000,- for 0.07 L/second of processed waste (40% for decorative plant's cost and 60% for digging cost and substance cost)

- The cost of ecotech garden is quite cheap (Ratna Hidayat, 2005) which is around US$300 per L/second of the processed waste. (US$1 = Rp 10.000, December 2005)

- Meanwhile, Grey water recycle in MIyako Island, Okinawa (Naoko, 2005) reaches US$ 797.538 per L/second of the processed waste or 2600 times to Ecotech Garden.

The difference is caused by the cheap cost of materials and expenses in Indonesia.

Operational Cost

- Ecotech Garden does not need operational cost
- Grey water recycle in Miyako Island needs operational cost because it employs pumps.

The benefits of Ecotech Garden

The benefits of implementing Ecotech Garden:

- The environment aesthetic increases
- In short term, the waste of BOD, Total-N and Total-P load to the river decreases,
- The unpleasant smell decreases. The indicator of the decrease of ammonia level is about 50% (at first the decrease reaches 10.50 mg/l and in outlet is for about 5.3 mg/L) while the minimum stink of domestic waste is about 6 mg/L (Arnold S. Vernik, 1987)
- The addition of income from selling the plant seeds is about Rp 219.000 per year or Rp 106.000 per $m^2$ even if the price will tend to decrease if there are some new decorative plants.

It is expected that Ecotech Garden can be applied in wider scale to maintain the water resource (river, dam or lake) quality in residential environment.

The opportunity of applying Ecotech Garden

- There are bigger opportunities for applying Ecotech Garden because most of grey water is wasted to gutter without being processed first.
- Even though some big cities are equipped by the central domestic Waste Water Recycling Installation which can channel grey water and black water, but the service scope is still low which is between 2.3 – 42%. The description is as follows:

Table of the waste water processing of the central inhabitants in Indonesia

| No | City | Total inhabitants | Inhabitants having sewerage | | IPAL Capacity (L/second) |
|---|---|---|---|---|---|
| | | | person | % | |
| 1. balikpapan | | | | | |
| 2. banjarmasin | | | | | |
| 3. bandung | | | | | |
| 4. cirebon | | | | | |
| 5. denpasar | | | | | |
| 6. jakarta | | | | | |
| 7. medan | | | | | |
| 8. prapat | | | | | |
| 9. surakarta | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 10. tangerang | | | | | |
| 11. yogyakarta | | | | | |
| Total | | | | | |

Source: Ratna HIdayat amd Simon S. Brahmana, 2008 in KLH, 2004

- Ecotech Garden can be applied individually in every house or if there is an empty land, it can be made collectively which can be such a garden in residence areas.

BANGUNAN AKUIFER BUATAN SIMPANAN AIR HUJAN (ABSAH)

Artificial aquifer for rainwater storage (ABSAH)

BACKGROUND

The traditional rainwater storages (PAH) have been built in this country as a part of autonomous water supplies by employing rainwater system. However, it can only be employed for a short time.

There are three types of rainwater storage constructions;

1) The traditional rainwater storage
   Is a water storage built simply. Generally, it has small volume which will not be enough to fulfill the needs of household water for a year. This matter is caused by not all of the gutters are installed in all roofs of the house.
2) The semi-rational rainwater storage
   Has the same volume as the house roof width times by the average rainfall annually.
3) Rational rainwater storage
   Has the optimal design volume in which the water taking volume will also be considered

The rainwater storage has a water quality problem as the result of undergoing no filtration in the beginning and of the unprotected water storage since it is constructed in widely opened or half-closed situation. Therefore, dirt, dust, small insects and pollution could easily get in there. Besides, since it also receives sunshine, the growth of moss and the occurrence of evaporation could also happen in it.

The rainwater will bring along all the material existing in the roof to the storage including corrosive slag. As the result, the stored rainwater in the storage has worse water quality than that of rainwater before falling to the roof. The water quality could get even worse if the water is kept for a long time in the storage. From five water sampling obtained from rainwater storage in Hargosari, Gunung Kidul, it is found that the muddiness of the water is around 28 -90.5 NTU and the level of $KMnO_4$ is around 53-71.8 mg/l which exceeds the limits for drinking water, which is around 5 NTU and 5.377 mg/l of $KMnO_4$ (Setiawan, 2008).

The Components and Functions of ABSAH

ABSAH consists of four containers;

1. Water Receiver Container
   It functions to store the rainwater coming from the roof gutters. Plastic gauze existing in pebble layer is installed in this container horizontally.

GBR1. Rooster, water receiver container, water exploiting container (hand pump and well), reservoir volume = 7.5 x 3.75 x 2.5 $m^3$ (rooster is given between partition), artificial aquifer, water storage container.

2. Artificial Aquifer Container
   Water from the water receiver container will then enter the artificial aquifer container, which is divided into some partitions, with panel as the partition border. Half of the partition borders do

not have holes and the other have holes filled by palm fiber. Between the two partition borders, there are, for example, pebble, sand, brick debris, charcoal from coconut shells or from woods, limestone or dolomite (for are having acid rain, but it is not necessary for the karsts area) and palm fiber as the filters. These materials function not only as filter but also as mineral adder from those materials to water through the contact of both matters. This process could reduce the unbeneficial physical, chemical, and biological of the water. Generally, sand and pebbles coming from volcanic activity have better filtration results and mineral contents than those coming from sedimentation. The longer the artificial aquifer container is, the better the water quality will be.

3. Water Storage Container
   This container is equipped by holes to do the checking and the estimation board to see the water height. From this container, then the water will flow to the exploiting container.
4. Water Exploiting Container
   The bottom wall of the well is in the form of the circled holed panels having palm fibers and surrounded by pebbles and sand. To exploit the water, the hand pump installed above the well is employed. It is important that the container must not leak and must be covered thoroughly. Typically, this container has 13 m or more in length, 5 m in width, and 2.5 m in depth (1.5 m inside the soil and 1 m above the surface) in which between the containers, there are holed panels given to flow the water.

The construction can be made by bricks strengthened by metal frame nets covered with plaster for outside wall and made by framed concrete for bottom construction. To guarantee its impermeability, framed concrete construction is the best choice for bottom construction and outside wall. However, for the inside wall and for the partition, it is better to use brick construction so that it can be changed easily if it is necessary.

GBR3. The insides of reservoir and artificial aquifer

The General Requirements for Constructing ABSAH

1) The rainwater trapped construction such as roof or slope area covered by impermeable plaster is provided.
2) The water storage dimension is designed like storage dam with the input of rainfall times by the width of rainwater storage, and with the output of water taking by the users for 365 days.

The aquifer and storage containers must be covered so the evaporation will not occur. The part which can stay open is only the water taking container. The cover is made of concrete metal sheet which can be lifted by one person and it must be arranged tightly so that there will not be any space for other water or polluted substances to enter artificial aquifer and storage. For the salty water area where the water cannot be used for certain activities or cannot fulfill the water quality standard for the users, the water mixing from the local water and from the storage water can be conducted with certain ratio.

The things that must be considered in keeping the combined constructions are:

1) Clean the water receiver container regularly at least once a year which is in the end of dry season
2) Clean the other parts at least once per ten years; always provide at least 3cm of water to maintain the humidity so that there will not be any fractures caused by the heat of the sun.
3) Do the wall strengthening, if necessary; always use iodine salt to cook food if the water does not contain the required iodine.

The Benefits and the Detriments of ABSAH

The benefits of constructing ABSAH are:

1) ABSAH is included in effective technologies. It considers effective and efficient from quantity, quality and expense (by choosing certain kinds of materials) aspects. Its effectiveness can be felt more in the area having problems with water supply.
2) The construction of communal ABSAH collectively is more competitive than the construction of *embung* which always experience the loss of water caused by evaporation and leak and which also need specific site.
3) The operation and maintenance does not need to be controlled by many people and does not need much cost. It can be managed by the local water users.
4) The water quality of ABSAH is better than the water quality of waste water processing (PAH) and also better than the surface water which is easily polluted (river, lake, pond, dam, *embung* and pool).
5) It is protected from pathogenic bacteria and viruses and from the growth of moss compared with surface water and water of PAH
6) The water quantity of ABSAH is more than that of the traditional PAH, but it has the same quantity with that of Rational PAH. You can get the optimum water supply, if the ABSAH is designed based on the optimum volume so that the water can be used optimally.
7) It requires minimum energy in which if it is needed, the energy from the technology application (windmills, solar cell) can be employed.
8) It can be used as the water for drinking, doing animal husbandry activity, farming, doing hydroponic activities, doing aero phonic activities, for making ice to preserve the fish, for water reserve, and for other necessities by doing the required adjustment.
9) It can be used as the reserved water when there occurs the urgent situations, such as disasters and the failure of water supply system operation. If the water storage is empty, it can be filled by other water from other sources.
10) The construction can be paid in installment by using the available local materials which can be perfected gradually.

The detriments of ABSAH

The detriments of constructing ABSAH are:

1) Technologically, it is ready to be used. However, a larger cost is required if it is to be placed under the dwellings and under general facilities (Therefore, the government must subsidize it)
2) In dry season, the additional water supply is required and it can be conducted by expanding the rainwater trapped area.

3) The socialization is hard to do because to make people understand what it is about, the detail explanation and the change of paradigm are necessary.

The applied site

1) The arid areas caused by climate factors such as in NTT, NTB
2) The water shortage areas caused by geological factors such as in the karsts area (Gunung, Sumba, South area in West Java)
3) Small islands having water shortage and needing water addition from the existing system
4) brine water area
5) the area whose water cannot be used to drink (for example, water containing higher level of Fe and Mn), such as Bangka, Belitung and the surrounding small islands
6) swamp area
7) hill area
8) the dwellings where there is no water storage system or where the water storage system always gets damaged
9) the scattered dwellings in the water shortage area

the well employing hand pump above the exploiting container

PINTU AIR OTOMATIS TAHAN KOROSI BAHAN FIBER RESIN

The automatic floodgate
Corrosion resistance
Fiber resin substance

Preface

In the development program, government plans on developing the farming land in tidal area to support the food program. The obstacles in managing the water resource in the tidal area are the acid turf soil, the specification of swamp in that area and the seawater intrusion.

The appropriate technology to be applied in such conditions is the anti-corrosion automatic floodgate. The automatic valve gates have been used widely in Indonesia and usually they are made of wood or metal. However, the typical problem mostly found concerning the automatic valve gate is related to the broken of the valve gate caused by its unsuitability with the nature condition causing the low working of the gate and sometimes the gate does not function at all.

Attempting to find the solution to the problems, Pusat Litbang Sumber Daya Air has conducted a research concerning the two automatic valve gate models made of anti-corrosion (fiber-resin) material; the squared PA-FGI type and the round PA-FG2 type.

Based on the physical model examination result in the laboratory, it can be concluded that with its own height the small gate can be changed by filling the gate hole with water, its hinge works well, the valve gate can operate well in the 2 cm distinction of water surface between the up river and the down river.

THE SPECIFICATION OF PUSAIR PA-FG1 TYPE VALVE GATE, 60 CM

Material

- Valve gate : fiber resin
- Gate hinge : metal sheet covered by fiber resin
- Water resistance system : Thick rubber 1-2 cm
- Weight controller faucet : PVC

Measurement

- Valve gate frame hole : 60 x 60 cm
- Squared gate frame (height x width x thick) : 100 x 120 x 3 cm
- Squared valve gate (height x width x thick) : 80 x 80 x 10 cm
- The width of the gate flense : 10 cm
- Valve gate hinge : 30 cm, d = 5 cm

The making process only needs a short time

Weight

- Gate (empty) : 9 kg
- Gate filled fully by water : 35 kg
- Mass weight of the gate (BJ) : 1 – 1.5 ton/$m^3$ (changeable)

Hydraulic data

- Min. head (mass weight = 0.5) : 2 cm
- Max. head (mass weight = 1.5) : 8 cm

Strengths

- Water endurance : 3 mm thickness = 3.4 kg/$cm^3$

Simple fabrication

STRENGTHS AND WEAKNESSES

The comparison parameter

The valve gate made of fiber resin material is compared to the valve gate made of wood, light concrete, metal and ferrocement:

The comparison is seen from

- The practicable technology
- Rigidity
- Power
- Firmness
- Gate weight
- Fracture
- Fabrication
- The accessible material
- Mobilization/transportation
- Installation
- Operation
- Leak
- Maintenance
- Cost

Strengths

- The gate weight (mass weight) is slightly lighter than any other material
- More resistant to fracture than the wood-made material
- Fabrication (the making process and the quality control) is more guaranteed
- Mobilization/transportation is more accessible
- The installation and operation is easier
- The occurrence of leak is lower which will reduce the maintenance cost
- Supported by the laboratory test by physical and material strength test

Weaknesses

- From the door's endurance of water, the metal, concrete (ferrocement) door is stronger than the fiber resin door.

- From the fabrication cost, the fiber resin door per unit of width is more expensive than the wood or concrete (ferrocement) door, especially if it is produced in small amount.

The valve gate is ready to be installed
The installation of funnel for the valve gate's hold placement
The installation of valve gate's hold body
The installation of valve gate's frame
The installed gate viewed from down river
The valve gate has operated for damming up the water
The trial of PA-FG1,120 valve gate in Ciaur, Central Java to prevent flood in highways
The condition of streams in up and down' side of valve gate: the door's hole
Hinge
Valve gate
gate's frame

The stream passing through the valve gate
The valve gate will open automatically if the surface water of the up side is higher than that of the down side and the valve gate will close automatically if the surface water of the down side is higher than that of the up side. The difference of surface water in height between the up side and the down side to open and close this fiber resin valve gate is only about 2-8 cm.

INSTALASI PENGOLAHAN AIR GAMBUT UNTUK PENYEDIAAN AIR BERSIH

THE INSTALLATION OF TURF PROCESSING FOR CLEAN WATER SUPPLY

The needs of clean water in the tidal and swamp areas

The society living in the tidal and swamp area in Sumatera and Borneo faces difficulties in obtaining clean water for their household needs, especially the drinking water. This matter happens because the spring in that area contains the acid brown turf water. The brown color of the water comes from the organic substances contained in the soil and the turf which form the polymer element containing the carboxyl acid and phenol group compounds. The acid of the turf is caused by the existence of clay containing sulfide which will then be oxidized to be sulfate acid.

Recalling the urgent needs of drinking water, the technology research and development of processing the turf water which can be applied by lower, middle, and higher scale in the village, urban, industrial and tourism area is required.

GBR1. The turf river: Batara River, Teluk Serdang Village, Tanjung Jabung Residence, Jambi Province

The Research of Turf Water Processing

The process of turf water processing in laboratory

The sample of turf water as the laboratory processing experiment is obtained from Gambut Subdistrict and Hulu Sungai Selatan Residence in which the turf water quality has some extreme characteristics; the pH is between 3.7 – 4.3, it is very brown with the PtCO color scale between 124-571, it contains higher KMnO4 scale between 38-280 mg/l, and it contains the level of Fe soluble metal between 0.45-5.96 mg/l, the level of Al from the undetected point up to 0.40 mg/l and Zn between 0.31-0.36 mg/l. (See Table 1).

GBR2. IPA Prototype with 60 Liter/minute capacity (PUS AIR - 124).
Site: Batara River, Teluk Serdang, Tanjung Jabung Residence, Jambi Province.

In order to make the turf water drinkable, the processing of organic substance level ($KMnO_4$), color, pH and Fe is required. The pointed processing of this research is the overdosed process of coagulant substance by employing the conventional water processing systems and tools which are widely used in the installation process of drinking water. The processing steps are as follows:

a) The beginning neutralization by calcium oxide
b) The coagulation process by alum and, if necessary, by active carbon
c) The final neutralization by calcium oxide
d) Filtration

GBR3. The before processing turf water and the after processing turf water.

Disinfection process is not conducted in the laboratory, but in the field prototype.

From the experiment result, it is found that turf water can be processed to be drinking water by employing the conventional tools and processes which are coagulation, filtration, and disinfection.

However, some modifications are required such as the beginning neutralization using 4-4.2 mg/l of CaO, overdosed coagulation using 100-320 mg/l of alum, and the final neutralization using 60-310 mg/l of CaO. The calcium oxide and alum doses are varied and depend on the pH and the color of the turf water.

This process can be applied only in turf water having 130 unit of PtCo as the maximum color and 60 mg/l organic substances ($KMnO_4$) as the maximum level. If the color and organic substance level is exceeding those values, the water can still be processed into drinking water which would fulfill the requirements if 10 mg/l carbon active is added. However, if the color level is exceeding 200 unit of PtCo and if the

organic substance ($KMnO_4$) is exceeding 80 mg/l, then ••••••••••••••••••••••••••••

The Application of the Experiment Result
Pus Air Gambut-3 Prototype
Generally, the diagram and process of flow processing of this prototype is the same with the previous prototype, but the difference is that this prototype is applied in an integrated and flexi glass-made unit.

Some distinctions with the previous types are:

1. The mechanical system only uses one pump used for either water or filter washing. The function of this pump is for activating the hydraulic energy of fast mixing, slow mixing and the whole process.
2. The chemical substance (alum and calcium oxide) placing system makes use of the absorbing power from the hydraulic energy of the stream in the pipe and from the height distinction between the solution tank and the placing point.
3. The stream system can be conducted openly and in the pressure condition (not in the open hydraulic stream).

This prototype is made into two types of hydraulic system. The distinction can be found in the sedimentation system in which in type A there is the sedimentation space while in type B the hydraulic stream is directly settled into the surface layer of the filtration.

Table 1. the quality of turf water and its processing result

| no | parameter | $1^{st}$ sample | | $2^{nd}$ sample | | $3^{rd}$ sample | | unit |
|---|---|---|---|---|---|---|---|---|
| | | pure | processed | pure | processed | pure | Processed | |
| | pH | | | | | | | |
| | Color | | | | | | | |
| | DHL | | | | | | | |
| | Muddiness | | | | | | | |
| | Al | | | | | | | |
| | $So_4$ | | | | | | | |
| | Na | | | | | | | |
| | Fe | | | | | | | |
| | Mn | | | | | | | |
| | Organic | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | substance | | | | | | | |
| | Hardness of water | | | | | | | |
| | Ca | | | | | | | |
| | Mg | | | | | | | |
| | Cl | | | | | | | |
| Dose | | | | | | | | |
| Alum Calcium Oxide | | | | | | | | |

tt: undetected

The Installation Trial of Pus Air Gambut-3 Prototype

The trial of Pus Air Gambut-3 Prototype is conducted in KLTA Puslitbang Teknologi Sumber Daya Air Laboratory and in Batara River, Teluk Serdang Village, Tungkal Ulu Sub district, Tanjung Jabung Residence, Jambi Province in July 1995. The result of water processing trial from both types can be seen in Table 2 and 3.

Table 2. the trial result of Pus Air Gambut 3 Prototype in laboratory

| no | parameter | Unit Mg/L | | Type A | | Type B | |
|---|---|---|---|---|---|---|---|
| | | | | Pure water | Processed water | Pure water | Processed water |
| | pH | | | | | | |
| | Color | | | | | | |
| | Muddiness | | | | | | |
| | Soluble residue | | | | | | |
| | Na | | | | | | |
| | Fe | | | | | | |
| | Mn | | | | | | |
| | Zn | | | | | | |
| | Al | | | | | | |
| | $So_4$ | | | | | | |
| | $KMnO_4$ | | | | | | |
| Dose | | | | | | | |
| Alum Calcium Oxide | | | | | | | |

The socialization of IPA Gambut

The minor scale of IPA Gambut for one village can be constructed directly in the local area because of the use of simple technology. This installation can be operated by local technicians after they get the training concerning the turf water processing and the installation operation. The construction cost to make the turf water processing installation (Pus Air Gambut-3 type) made of flexi glass with 5 liter/minute capacity is about Rp 4.000.000,- and if it is made of metal material, the cost is about Rp 5.000.000,- in 1996. If this prototype is operated 24 hours/day, then it can serve 100 people with the assumption that the need of water per day is 85 liter/person. Therefore, this IPA Gambut can be appropriately applied in industrial and tourism area having turf water.
The level of the color is more than 200 unit of PtCo and the level of organic substance ($KMnO_4$) exceeds the overuse of chemical substance, except if there is no other alternative.

Table 3. The trial result of Pus Air Gambut-3 Prototype in Batara River, Teluk Serdang Village, TUngkal Ulu Sub district, Tanjung Jabung Residence, Jambi Province (The average result of trial in July 1995).

| no | parameter | Unit Mg/L | | Type A | | Type B | |
|---|---|---|---|---|---|---|---|
| | | | | Pure water | Processed water | Pure water | Processed water |
| | pH | | | | | | |
| | Color | | | | | | |
| | Muddiness | | | | | | |
| | Soluble residue | | | | | | |
| | Na | | | | | | |
| | Fe | | | | | | |
| | Mn | | | | | | |
| | Zn | | | | | | |
| | Al | | | | | | |
| | $So_4$ | | | | | | |
| | $KMnO_4$ | | | | | | |
| Dose | | | | | | | |
| Alum Calcium Oxide | | | | | | | |

tt: undetected

Table 4. Operational cost, maintenance, and water cost for IPA Gambut with 1 liter/second capacity with 24hours/day operational time.

| Cost description | ordinary river | turf water | | |
|---|---|---|---|---|
| | | color | color | color |
| Chemical substance | | | | |
| Electricity/power supply<br>Operator | | | | |
| Maintenance | | | | |
| total | | | | |