**ORIGINAL RESEARCH PAPER**

**SOLUTION NATURAL BALANCE TO OVERCOME FLOODS, LANDSLIDES, DROUGHTS**

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**Abstract**

Trenggalek District, Indonesia was high rainfall per year. High rainfall had to be absorbed in the soil with infiltration wells and trees with strong roots and absorbed large amounts of water. Objective: Surface water had to be managed properly so as not to erode fertile soil in the rainy season and become water reserves in the dry season. Secondary data namely reported on natural disaster management studies, geography, and geological maps. In a simple analyzed concept, water that was naturally absorbed by plants, infiltration wells, and water could be used for the community, taken by pumping. Novelty answered the three main problems of the community during the rainy and dry seasons, integrated solutions with the principle of natural balance, and avoid disaster. A simple implementation could be easily applied to any location around the world if professional detailed drawings match the concept with due regard to the local catchment area. Ten plant solutions that absorb surface water, infiltration wells to groundwater, fresh air, and agricultural tourism, so that there was no flood and no erosion during the rainy season. In addition, people could get clean water in dry weather, avoiding seawater intrusion, and land subsidence.

*Keywords: Overcome sliding, flood, and drought integrated, , Simple concept overcome disaster integrated, easy implementation, benefits for the community.*

**Statement of Industrial Relevance**

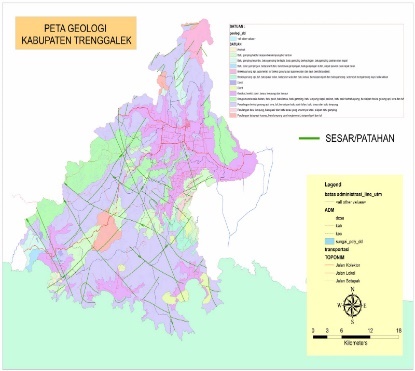
The topography of Indonesia varied greatly from hills to lowlands with very sharp differences in soil level. High rainfall during the rainy season but low rainfall during the dry season. The land was very fertile, especially on the island of Java, Indonesia, but slides easily. The solution of my manuscript was that the hydrological cycle and the balance of nature had to be maintained so that disasters did not occur

NOMENCLATURE

INTRODUCTION

The author was surveyed in Trenggalek, Pacitan, Ponorogo district Indonesia. The land was contoured, prone to landslides and lowland flooded, Trenggalek District (figure 1a, 1b) rainfall from January to December 2017 was 315,278,304,216,161,83, 66,36, 55,123,168,255 mm. The differences in dry month precipitation and wet months were 279 mm. The data showed that the high rainfall in three months of the previous year until the beginning of the three months following year had to be managed properly.



Figure 1a,1b,1c Trenggalek Distrik Location in Indonesia and geology [22],[4],[8]

High rainfall was very beneficial for the dried season water reserves. High rainwater must be absorbed into the soil by plants and infiltration wells. In the hills, green trees that have strong roots and absorb a lot of water, avoiding long flowing water that will erode the soil, for example, trees, Eucalyptus Suren, Bayur for hills, lowlands near rivers or drainages where plants absorb a lot of water but the roots are less strong than Yellow Bamboo. (flavoquisfermentum).

High rainfall is absorbed into the soil by planting various types of suitable trees and surface water with infiltration wells to deep groundwater, especially in the river and hilly areas. Hypothesis: If high rainfall is not absorbed it will have an impact on drought in the dry season and cause floods and landslides, which will suffer the community and increase poverty in Trenggalek Regency, Indonesia (figure 1c). Indonesia's Trenggalek Regency consists of 2/3 of high-level landslide-prone soils, survey results show that landslide-prone soils consist of volcanic clay. Hilly areas are dominated by low-income settlements that mostly occupy suburban or rural areas. The simple concept of overcoming floods, landslides, and droughts according to my script follows the implementation of low-income communities. They setle for the hilly soil and fertility of Java so that people can support themselves by farming.

The highlands are fertile but easy to slide soil. Many home industries can be used as solutions to overcome landslides, floods, and droughts, such as knitting reinforced bamboo (fig. natural potentials such as boulders and limestones can be utilized as sub-structures.

Objective: Surface water had be to infiltrate properly so not landslides and eroding fertile soil in the rainy season and become ground water reserves in the dry season. Beside that avoid land subsidence

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Fig 2a.Reinforced bamboo knitting Fig 2b Bamboo house Fig 2cThe water surface entered soil

Previous research gaps, landslides, floods, and drought were not integrated solutions but overcome each solution, usually handled or solution with infrastructure, no natural solutions, and local wisdom not like the solution in my manuscript. This research addressed the dominant natural solution; if necessary strengthening was preferred using material local wisdom.

In the hydrological cycle, surface water is infused ground as an important ecosystem of the Earth. That provided valuable services to society, such as minimizing the effects of flooded, acting sink carbon, purifying available surface water, and agro-tourism opportunities.

The environmental change increased, which caused huge losses in terms of ecosystems and had a large impact on the human community. As such, global thinkers, environmentalists, scientists, and policymakers focus on finding solutions and ways to sustain life on Earth [Mohamed, A. M (2017] Ecosystems must be maintained properly if the special feature toward resilient dealing and governance flood damage risk will be prevented with mitigation. Suykens, C., S. J. et.al. (2016).

Determine the balance against flooding, especially at the individual level Suykens, C., S. J. et.al. (2016). The hydrological cycle had to be a concern, especially in the management of rainwater to overcome floods in the rainy season and drought in the dry season and avoided erosions.

To overcome the prevention problem an erosion prediction system has been developed in 2013. This system aims to estimate rainfall erosions at the national and local levels by integrating erosion vulnerability maps, rainfall threshold values, rainfall forecast models, and Al-RawasA. A, et al (2016) inform residents of the likelihood of increased erosion events. Suykens, C., S. J. et. all. (2016).

High rainfall needed to be monitored in the case of flash floods and landslides. Highland high rainfall needed to calculate to be absorbed into deep groundwater, flash floods could be avoided.

To generate index value monitoring information probability, average percent, and precipitation deficit during drought allows a consistent new definition set of information to be counted, including the drought and end intensity magnitude. Thomas B. et al (1993) To anticipate drought, used groundwater necessary calculated use with the percentage of rainfall that could be absorbed.

The existing natural terraces balance was the maintenance of groundwater from the root plant. The land was conditioned to remain as it was originally so that the soil did not erode by surface water but was absorbed ground, and the remaining horizontal force was held by the retaining wall of stone by installing a counterfort/stiffener in the area of ​​potential shear so that it is sturdy(Triastuti N.S. 2017) Existing contour conditions should be maintained. If the land had to be changed needed groundwater level remained, and erosion was avoided by planting root trees whose water absorption Triastuti.N. S (2018)

The planting prevented natural erosions, the high land planted Eucalyptus greening trees. Groundwater that was too high caused an unstable soil structure. Eucalyptus had a high amount of water absorption, which could prevent puddles, and eucalyptus protected unstable soil environments, such as erosions. In addition, eucalyptus rapid growth, they are easy to maintain. Forbes, K. et al. (2011)

**MATERIAL and METHOD**

Methodology The author surveyed many villages happened disaster slides and cracked soil. Geography map the Trenggalek district government gave a study of soil movement final report of disaster natural management. Prambadi, H (2017) The current journal took on the idea and understood These references were the current journal of soil, land used, deforests, trees, website, and previous reports of the field at that time. A three-institutions user approach discussion as below:

BAPEDA, Regional Device Work Unit ( SKPD/SatuanKerjaPerangkat Daerah), organized got focused group discussions to obtain information and data on aspects of the various Activision movements. Thomas B. et al (1993)the neighborhood chairmen and village people participated and discussed at the yard house. The people showed the location of the disaster.

The district and regional head indicate sometimes the dry season was drought, while the wet seasons were landslides and floods. People live living on the hill asked to be moved to a location with relatively smaller or no potential landslides

1. Data

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| --- | --- |
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Figure 3a.3b. Type of soil cracks during the dry season, landslides during rain, and slope >45° Engineering Faculty of Gajah Mada University. (2017)

The author focused on managing surface water so as not to cause catastrophe and on storing surface water so that it was used during the dry season.

Observation of the field was as follows:

Information from the regional head of Trenggalek that the dry season was lacking in water and the rainy season was eroded land as the author saw directly.

BAPPEDA Trenggalek (Regional Development Planning Board of Trenggalek) interviewed village people and officials. In the dry season residents happened drought, while in the rainy season, the community happened landslide/disaster landslides/disasters, so people felt uncomfortable. A total of 361 scattered springs were recorded in each district as sources of water, and most had been utilized.

Some of the root trees did not strong enough to resist the soil and pushed the building and infrastructure, existing plants were observed, but no varieties of trees and no planting pattern The water source and surface water were not well organized, so it added pressure to the movement of the soil flows wild all directions were damaging

a mosque, infrastructure, and house

(ii) Soil was easy to landslide or break

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| --- | --- | --- |
|  |  |  |

Figure 4. House, and infrastructure damaged (author document)

Secondary data:

Geologists analyzed geological maps of ESDM 2016 (Ministry of Energy and Mineral Resources) and collected secondary data from Deforestry (Ministry of Environment). [dAsalbantani,(2018)

Internet sources of 15 trees protected by the government Trenggalek District (2016).

The Internet sources of Ministry Energy and Mineral Resources had geological results and were from the geological association’s Engineering Faculty of Gajah Mada University. (2017)

Information was obtained from the internet Ministry of Energy and Mineral Resources. Formation of soil Hydrological and data rainfall from Metrology and Geophysics ESDM (2011). Topography of the internet Bakosurtanal (National Coordinating Agency for Surveys and Mapping) Park K, Oh H, Won J.hun (2021) collecting secondary data of forestry destruction (Ministry of Environment dAsalbantani,(2018), Prambadi, H (2017).

Data Analyzed.

Plants that need to be planted in the highest to medium-high hill areas should be planted in 15 variety plants protected by the government Trenggalek District (2016) to help the government preserve 15 variety plants. If abundant, it was permissible to cut plants, and planting the tree remains sustainable. If the abundant tree was sold, it had a high selling value, which helped the local government and the community increased their income. The highest tallest hill planted absorbs a large amount of water and fresh water was available during the dry season, for example, the eucalyptus tree, and on the middle hill level variety of trees planted that absorb less water but relatively quickly harvest, for example, Suren and Bayur. Root bamboo trees planted in lowlands absorb water to prevent flooding, and as a reserve in the dry season, plant placement must be adapted to the suitable soil quality and the environment.

Data Analysis in Engineering

The contour of the original land was retained (figure 5) only trimmed and adjusted to the site of the building to be placed. It was necessary to test the soil structure and soil fertility.

Stones or reinforced concrete walls installed small drain holes in some parts of the wall surface so surface water flew out as slope stabilization, as civil engineering approach.

Planting protected plants so that the growth of many plants and the community was selling at relatively high prices. Combined with shallow and middle groundwater infiltration well(figure 2 c) in altitudes and hills, while in the lowlands, infiltration well shallow groundwater



Figure 5 Contour of the original land was retained

RESULTS

The result was solutions to landslides, floods, and drought, and retaining the ecological environment improved the quality of the environment with strong-rooted, oxygen-producing rare plants. This research integrated a solution to overcome floods, landslides, and drought analyzed and calculated the balance of nature. Communities benefit from an oxygen-rich environment and increased community income with wood products. All surface water is put into groundwater, and communities got fresh water and natural resources benefit. This solution was simple, cheap, easy implemented in rural communities, and increased the quality of the environment

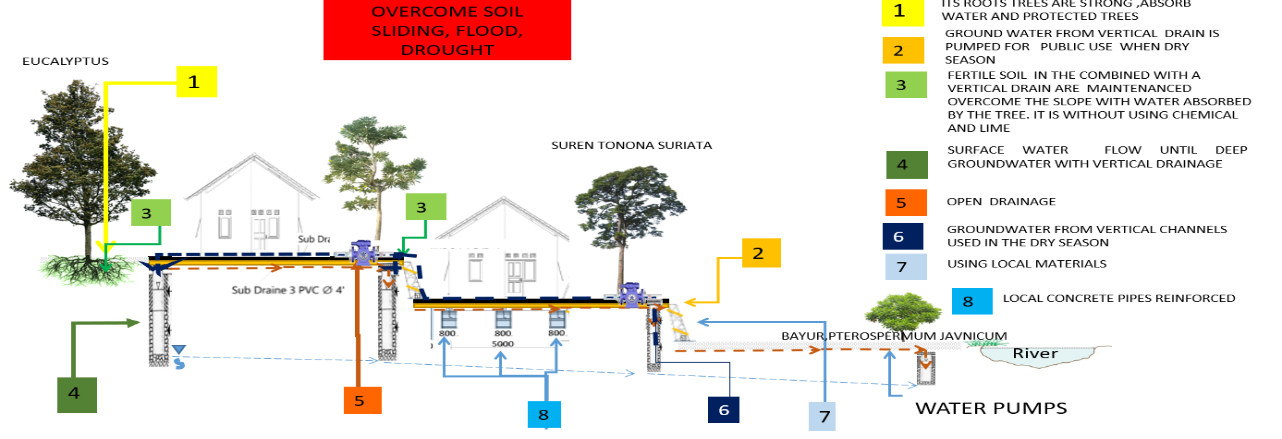


Figure 6. Solutions to overcome landslides, floods, and drought  integrated for low-income communities or a limited budget in the district or local government in the world

The soil was fertile, contour retained, and surface water absorbed by trees and infiltration wells from the highest hill to the lowlands, a retaining wall combined with a modest engineering structure to overcome the slope sliding. If fertile land eroded, was detrimental to farmers and the agricultural community because the crop yields were decreasing, which certainly had an impact on reduced income and welfare. They created vertical drains that deeply infiltrated the groundwater until the sand soil layers. A vertical drain pipe reserved water during the dry season so that groundwater could be taken with the pump, not at one point but at another hole was alternately and the volume calculated so that no ground cracks or landslides occur because groundwater reduced drastically. The use of water by the community needed to be analyzed and calculated, so that reduced groundwater that did not cause land subsidence, addition, avoids the potential for landslides

Planted large trees, especially rare ones such as Eucalyptus, suren, bayur, small sapodilla, and Flavor quisfermentum absorbed water and prevented sliding. It could be used for agrotourism so it had multiple functions to prevent landslides, water reserve, and productive plant, agrotourism. Besides land subsidence could be prevented or reduced in an area, city, or district.

Steady existing elevation conditions that needed to be formed terracing Retained contour was the balance of nature, very beautiful because of different elevations, and the plants were visible from a distance. Certainly, it gave benefits an eye healthy and rich oxygen because of the green area. The drainage of surface water connected so that everything was accommodated and entered into infiltration wells, and it is necessary to treat household wastewater, the home industry, and factories. Terracing whose soil sloped was greater than the soil shear angle> 30° used a retaining wall from river stone and gave reinforced concrete frames. The bamboo bar was covered with fiber knitted for distillation function, bamboo was easily available around the location and strong withstand surface water stream. Subdrain PVC pipe or circle pipe concrete installed slope under the building and infrastructure. Therefore, the surface water did not push the building.

Solutions for building and infrastructure in the village had to be cheap by utilizing local wisdom, Simple tools and equipment are used so that they are easy to carry in rural areas and with relatively light upper buildings, such as knitted bamboo walls and frame concrete upper structures. The implementation solution could succeed in all locations if the author was allowed to survey another location, of course, complete with detailed drawings,

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DISCUSSION

The highest and lowest rainfall differ greatly by 8.7 times. The highest rainfall was 315 mm in January 2017, followed by 278 mm in February 2017 and 304 mm in rainfall in March 2017, especially if the December 2016 rainfall was approximately 255 mm. In January 2017, the land was saturated, had not yet evaporated or seeped into groundwater, and had high rainfall again. Park K, Oh H, Won J.hun (2021)

If it is not directly absorbed into the groundwater, it will cause a large force of water mixed with the soil to push or slide. Then, rainwater and surface water must be absorbed directly per area (spot). Professional engineers had to determine infiltration up to deep or shallow groundwater. If the highlands had infiltration wells to deep groundwater, the lowlands had infiltration wells too shallow groundwater and use local products made by residents as local wisdom. The infiltration had multiple functions to prevent landslides and as a reserve of clean water, was very beneficial for the community, especially during the dry season.

My manuscript provided a solution to overcome landslides by retaining the balance of nature, preserving a healthy environment, and providing benefits to the community and government. During high rainfall and drought. All my manuscript solutions protected nature by retaining existing conditions despite the construction of many buildings and infrastructure. Other research overcame landslides with engineering structures differently compared to my manuscript. The balance of nature and ecosystem disrupted could be improved following my manuscript's guidance

Panggul Village in Trenggalek districts, Indonesia, the soil of easy slide and black color indicated montmorrelite soil as very expansive soil

Table 1. Montmorrelite value range. expansive soil in general, including Panggul district Trenggalek. Index tests, Data

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CC | PI\*3 | SI\*3 | SL\*1 | PE (%) | DOE |
| >28 | >32 | >40 | <11 | >10 | Very high |

The location was steep, with a slope of 45-50 degrees (Forbes, K. et al. 2011)

Soil fertility should not be changed with 3 types of stability, namely, mechanical, physical, and chemical, but my manuscript had lower stability costs. Rainfall during the rainy season in the Trenggalek district was relatively high. It was necessary to water manage a water reserve and not erode buildings and infrastructure.

High rainfall slides soil slope over 45 degrees if the retaining wall was less strong structure. The flood-caused landslides had to be prevented by stored water, planting rare trees that absorbed water and put water into groundwater, utilized surface water to be used during the three-month dry season was 66 mm, 36 mm, and 55 mm the right solution to overcome drought surface

The highest hill had water in plants Eucalyptus that absorbed water, runoff into infiltration wells made up to the depth of groundwater (in the dry season), the hill with medium level planted Suren and Bayur plants whose roots were strong but easy short time produced, in low-lying areas the runoff did not flow heavy put into infiltration wells until the shallow groundwater, the rest received by yellow bamboo plants and rivers. The principle was to keep surface water from being discharged into the sea. Surface water didn't become salty, freshwater was easier and cheaper to treat and kept environmental sustainability. The river that leads to the sea had to be managed, for example, surface water was calculated folder volume accorded to the catchment area. The folder volume was not large because infiltration wells can be scattered in all areas. All infiltration wells had to be closed so safe living creatures not enter, but water could enter into infiltration wells. In the dry season, infiltration wells inserted pipes for pumping as community needs.

Most urban planning facilities and assets with sufficiently large economies of scale are required to increase resilience to disaster response. Ministry of Energy and Mineral (2017)

Drought is one of the main obstacles to the development of agricultural countries, such as Bangladesh. The meteorologists used popular measures based on the SPI (standardized precipitation index) to determine and monitored drought. The research results showed that the season influenced mostly on the SPI series higher with a time scale of 12 months. The predictive strength of the fitted model is evaluated taking into account different accuracy measures. Al-RawasA. A, et al (2016)

Rainfall-runoff estimation is a very important process in hydrology.

Physical phenomena are often an expensive affair (ESDM 2016). This case study was conducted in Trenggalek District because, in detail, the data support it, facilitated by Trenggalek District Leaders and their staff. The right solution needed, among others

Surface water had to be absorbed by trees/plants as groundwater to reserve water during the dry season. Soil fertility had to be retained did not use chemical or lime soil that could withstand the soil that easily slide or erode but caused infertile soil.

The abundant surface water during the rainy season needed to be entered into shallow and deep groundwater. The location of the vertical drain/infiltration well had to spread from the highest hill to the lowlands. Surface water was given a filter before entering the vertical drain/infiltration well so that the incoming surface water was of the same quality as the rainwater.

H =AgIT-AsKT (1)

Aw

Ag = Extent of area g

Aw = Area of the well (m2)

H = Height of water in a well (n)

I = Rain intensity (m / j)

K = soil permeability coefficient (m / j)

Pw = circumference of well (n)

T = Duration of rain/flow (j)

Calculation of H to ensure the water level in the infiltration well to determine the diameter of the infiltration well

Storage of water with vertical draining and rare plants was chosen so that they added value to the environment and people's income.

The contour of the land was as much as possible retained so that there was no new balance that disasters results.

Modification of slope geometry combined with reinforcement structure could achieve slope stability

The infrastructure and housing environment had to remain environmentally friendly, the soil should be fertile in the yard of the house or building, and the retaining wall had to be able to withstand land movements.

The substructure had to be bound to one another, and unity with upper structures had to be strong to resist erosion building. Subdrainage was installed in each building and infrastructure to flow surface water.

Surface water had to be prevented from flowing wild and stagnating so that the soil did not slide. The force of the water had to be channeled so as not to damage buildings and infrastructure.

The philosophy was that the load did not all retain but was partially distributed so that the engineering structure was not too expensive. The engineering structure did not fatigue expect long-lifetime building. Solutions for sliding soil in the village had to be cheap, should not damage soil fertility, and be retained for life sources, local material used to easily obtain, ease of construction, and simple equipment work.

The analysis had to meet 10 (ten) conditioning above and a steady contour. Plants from the highest hills to the lowlands were scattered with the criteria of plants that were rooted very strongly and deep roots with very large benefits for the ecosystem, and increased community income. Using transplant and spacing according to the provisions/standard and plant beneficially, if managed properly, every quarterly period will generate income for the community. It needs to be regulated by community leaders and local government authorities. There had to be written socialization and regulations signed by the community so that the infrastructure and planting product did not cause disputes and provided many benefits to the community and living things.

The natural balance happened if contoured land retained remain

and the active soil pressure installed retaining wall. The author analyzed soil isolated

P =0.5KaƔH2 (2)

P = active force

Ka = active ground pressure coefficient.

Hrw = Height retaining wall.

Ɣ = weight of soil volume.

The active force was small because the distance contour of the soil was relatively small

Groundwater or surface water had to flow via sub-drains to avoid damaging the structure so

Sub-drain impacted the loss of energy ƛLv2 / (D.2g) (3)

Lp = length of pipe, D = pipe diameter, V = velocity of flow, g = gravity value

The soil existing should remain fertile, and the existing elevation did not change. Concrete circle hollow pushed enter ground land, the inner soil had to took installed reinforced and concrete poured. The vertical load and horizontal load of the active soil pressure were accepted circle-reinforced concrete as a shallow bore foundation [15]

Qult = [Qb (Ahxqc)+Qs (AsxFs)]/*Sf* (4)

Qb = End bearing capacity (kg)

Ah = Cross-sectional area (cm²)

As = Area of skin (cm²)

Fs = Friction resistance (kg/cm²)

qc = Average pressure (kg/cm²)

Qs = carrying capacity (kg)

Qult = Limit carrying capacity (kg)

Sf = Safety Factor

Shallow foundation-bearing capacity had to be able to retain horizontal forces

Mobilization of materials and work tools to adjust existing terraces with human power

Subdrain material, i.e., bamboo, hollow circled concrete, and PVC pipe, which paid attention to sub-drains, was not covered in soil, so it needed to be covered with knitted bamboo, geotextile, and gunny sack.

Created unity in the upper and lower structures so that land subsidence occurred together.

EI/L=stiffness (5)

E = Modulus elasticity;

Im = moment inertia,

L = span of structure.

The inertia moment stiffness was enlarged by unity for the lower and upper structures so that it was very rigid, with no difference in a settlement.

Subdrain of PVC pieces, bamboo available. The soil should be kept with little water content, and it is not expand

The water discharge of pressure

Q = VA (6)

or water pressure Ɣair. Hb (7)

Q =flow rate is equal to the area of flow times the velocity of flow

A = Area of flow

V = Velocity of flow

The sub-drain under buildings, houses, or infrastructure eliminated horizontal force due to surface water, thereby reducing force at structure, reducing fatigue structure, and making it more cost-effective. The surface water flew into the drainage and was well managed by the community to recycle.

**CONCLUSION**

This solution could be applied all over the world with ground different contours, problems of easy sliding soil, floods in the rain or snow season, and drought in the dry season. Novelty three main problems during the rainy and dry seasons overcame an integrated solution with the principle of existing natural balance, ecology, many variation plants, available sufficient oxygen, added benefits to ecotourism, oxygen rich impacted healthy and local material dominant used. All solutions help people's lives become more established, comfortable, and prosperous. Conceptually simple but great impact on communities and could implement applicable worldwide and professionally adapted to the local environment

From upstream to downstream, it was guarded and addressed as a balanced ecosystem.

Abundant surface water during the rainy season had to be accommodated thoroughly as groundwater so that it became a water source in the dry season. Water infiltration wells are installed piped and pumped for community needs but need to be managed by taking into account groundwater used and groundwater suction at different locations so that groundwater elevation did not drop dramatically. In addition, surface water absorbed and entered the infiltration well did not flow far, so it did not erode fertile soil and caused erosion.

Another effect avoided or reduced land subsidence in a region or district if rainwater was directly introduced into deep groundwater and shallow groundwater in addition avoided the intrusion of seawater into the mainland. The solution was simple but needed to be analyzed by a professional engineering team so that the appropriate design of natural and artificial recharge, plants absorbed and drainage However, the government and people needed to care about survival and kept people healthy, and happy because they did not pressure in the face of disasters

NOMENCLATURE

A = Area of flow

Ag  = Extent of area g

Ah = Cross-sectional area (cm²)

As = Area of skin (cm²)

Aw = Area of the well (m2)

CC = Colloid Content

D = pipe diameter

DOE = Degree of Expansive

E = Modulus elasticity;

Fs = Friction resistance (kg/cm²)

g = gravity

H = Height of water in a well (n)

Hrw  = Height retaining wall

I = Rain intensity (m / j)

Im = moment inertia,

L = span of structure

Lp  = length of pipe

K = soil permeability coefficient (m / j)

Ka = active ground pressure coefficient

P = active force

PE = Percentage Expansive

PI = Plasticity Index

PVC = Poli Vinyl Chloride.

Pw = circumference of well (n)

Q = flowrate

Qb = End bearing capacity (kg)

qc = Average pressure (kg/cm²)

Qs = carrying capacity (kg)

Qult = Limit carrying capacity (kg)

Sf = Safety Factor

SI = Shrinkage Index

SL = Shrinkage limit

T = Duration of rain/flow (j)

V = Velocity of Flow

Ɣ = weight of soil volume.

Ɣair = Specific gravity of water

Hb = Height from the water level

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