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WATER CONSERVATION TECHNOLOGY INNOVATION ON DRY LAND: STUDY OF RESTORATION OF THE ROTE NDAO TOURISM AREA

Paul G. Tamelan[1], Maximilian M. J Kapa[2], Harijono[3]

[1]Faculty of Education and Training, Universitas Nusa Cendana, INDONESIA
[2]Faculty of Agriculture, Universitas Nusa Cendana, INDONESIA
[3]Faculty of Education and Training, Universitas Nusa Cendana, INDONESIA

Abstract
The dry land conservation approach has always had problems due to water scarcity. Water is a vital natural resource for all living things. Water shortages are caused by unorganized rainfall management, inadequate facilities and infrastructure, and lack of vegetation to retain and absorb water into the soil, even though the total rainfall input is sufficient. The main land conservation model is expected to be used as part of the efforts to conserve water resources in the Rote Ndao area, NTT. Descriptive research method and multiple regression analysis model are used to identify the condition of the land by assessing the ability of the land to absorb rainwater. Water conservation innovations with land criticality levels are classified based on input, output, and storage potential. Infiltration potential was assessed using data on slope, soil type, rainfall intensity, and land use. The analysis uses techniques to build geographic information systems. Soil slope in key locations requires tillage methods and planting design for forest products. The results showed that climatic conditions and rainfall in rural areas on dry land often resulted in a household water deficit, so the management was for water supply by accommodating additional rainwater in the form of surface runoff. Infiltration wells and reservoirs, vegetation/forests, and infiltration wells to collect surface runoff rainwater into the ground to achieve zero runoff are selected as water conservation innovations. This water-saving solution is beneficial for tourism development.
Keywords: Dry land, Water Conservation Innovation, Tourism

Introduction

All areas of existence are highly dependent on water supply. Water is essential for the life and well-being of all living things. That's one of the problems related to water resources that we are facing today. In most cases, the water crisis is triggered by the demand for water that is greater than the supply.

One of the regencies in East Nusa Tenggara Province, Rote Ndao Regency has a fairly wide space and potential but lacks water to meet the needs of the community, agriculture, and tourism. In Rote Ndao District, there is a flat, hilly landscape and many basin areas that can store runoff water. Infiltration wells and reservoirs can be used to overcome this problem. Reservoir is one of the infrastructures in an effort to accommodate excess rainwater during the rainy season so that it can be used for the needs of the population, agriculture, and raw water supply in this research area.

The expansion of tourism in an area will cause an increase in the amount of runoff because the open space to absorb runoff water is decreasing. In order for the infiltration process to be successful, Yunanto (2007) explained that there are three processes that cannot be separated and support each other to achieve the infiltration goal, namely: 1) rainwater infiltration through soil pores, 2) collecting rainwater in the soil. , and (3) water flows through the bottom, sides, and top of the soil. In accordance with the ability and designation of a land to support sustainable development and its sustainable existence, Law Number 37 of 2014 concerning Soil and Water Conservation aims to protect, restore, enhance, and maintain the function of the land in Article 1 Paragraph 2.

According to Sharda (2009), Guo et al. (2020), Yang et al. (2020), Sharannya et al. (2020), Berti et al. (2020), Dibaba et al. (2020), Darbandsari, P., & Coulibaly (2020), Tan et al. (2020), Wang et al. (2021),the hydrological process cannot be separated from the availability of water, where rainfall is distributed to various kinds of flows, namely water. Soil moisture is created when water falls to the ground. Flowing through rock crevices, will reach the base flow as runoff discharge and is absorbed by the soil. Rainfall is the main source of water. Surface runoff, intermediate runoff, and ground runoff are all methods by which rain that falls on the earth's surface is dispersed. Humidity, topography, wind speed and direction, temperature, and slope all affect how much rain falls in an area.

Planning, implementation, and evaluation of water resources management is part of Water Resources Management (SDA). As a result, people are less worried about water conservation because it is generally misunderstood that the government is fully responsible. To maintain water quality, the government has made various efforts, including building dams, reforestation, embankments to prevent flooding and erosion, forest conservation, determination of forest designation areas, establishment of river protected areas, construction of abrasion retaining embankments to keep sea water out, and building reservoirs. filters, for example. Lack of integration between activities, including lack of coordination between government agencies, communities and stakeholders, which causes most water conservation efforts to fail and go to waste, as evidenced by the construction of water infrastructure is only carried out by one person. agencies/departments as sectoral egos. An infrastructure cannot work optimally due to a lack of assistance from other sectors. If natural water sources are no longer filled or dry up in rural areas, it will be difficult for villagers to receive water, or if water sources are available but cannot be drained adequately due to costs and difficult coverage, villagers will have difficulty accessing water. As stated by Moerwanto, (2013), integrated water resources management is a strategy that fosters integration between development and management of water, land, and other resources in order to maximize socio-economic welfare and pay attention to environmental sustainability.

Research methods

Research with a water discharge survey approach and continuous water monitoring is used in conjunction with survey study methods to determine the current state of the resource. It is then necessary to conduct a study of the water demand for this resource, followed by an assessment of the water balance. Water balance analysis can be used to determine the next step in the development of water resources. Rainfall data, groundwater infiltration data, dry land agricultural management strategies based on the identification of land conditions, and the ability of the land to absorb (infiltrate) rainwater were collected during field observations. Rainwater runoff was analyzed in terms of land criticality, slope, soil type, and elevation. By using descriptive methods and regression models, researchers can simulate and predict land use changes in water catchment areas. Using mathematical models to evaluate groundwater conservation capacity Rainwater seeps into the soil through the use of water conservation principles, with the main objective of reducing water consumption.

Rainwater infiltration in the catchment area is modeled using several linear regression equations, and this is what is meant by a mathematical model of water resources conservation.

statistical analysis function Y = f(x1, x2, x3, x4, x5, x6, x7, x8) ....(1)

where,

Y = volume of water from conservation of water resources., a = intercept, b1, b2, b3, = regression coefficient, x1 = rainfall, x2 = field gardens, x3 = grassland, x4 = settlements, x5 = shrubs, x6 = reservoir, x7 = infiltration well. x8 = forest

Equation of water balance (hydrological):

I = O + S , where,

I = input (water entering) into the system, precipitation (rain), subsurface water flow, irrigation and so on., O = output (water out) of the system, in the form of evaporation, run off and subsurface, evapotranspiration, drainage , S = change in water storage, in the form of surface and subsurface deposits such as lakes, reservoirs, groundwater and soil moisture

Input (I) is assumed to be the Total Rain that falls to the Catchment Area

Input (water entering) into the system, namely all water potential in the form of water sources including precipitation (rain), subsurface water flow, irrigation and so on, so it is assumed that I (input) = V (amount of incoming water). For that Susilo (2012) explains that to calculate the volume of water due to rain as follows:

$d = \frac{V}{A} \quad atau \quad V = d\,A$ ....(2)

where :

V = incoming water volume (m3), d = inundation height or average annual CH period (n) years, A = drainage area

All rainwater that falls into the catchment area is assumed to be input, but in reality there will be water loss in the process of availability, namely some water loss in the form of runoff/surface runoff, evapotranspiration from soil and vegetation. The remainder of the difference in input and water loss will be used as storage (water availability) which will be used for agricultural, domestic and livestock needs. Not all of the remaining storage can be utilized directly because it consists of surface water that is accommodated above the ground surface and water that enters the soil as infiltration used by agriculture, and the rest is passed on as percolation directly into the ground water.

Water Loss due to Surface Runoff (Runoff)

To estimate the peak runoff discharge, Mahmud (2011) recommends using a logical method. The Lloyd-Davies formula has been used in England since 1906. The rainfall intensity of an area and the drainage area of the area are used to calculate peak discharge (Qp). In accordance with the research objective, rainwater conservation efforts, the Lloyd-Davies formula is used in calculating the amount of surface runoff which has been modified based on land cover variations by Supirin (2004) for drainage areas with drainage systems to calculate the amount of surface runoff. To determine the peak discharge (Qp) if the land use is not homogeneous, the following equation is used.

Qp = 0.00278 I CiAi ....(3)

where :

Qp = magnitude of peak runoff discharge (m3/s) will be calculated as the sum of each peak discharge from each type of land cover., I = rainfall intensity (mm/hour) calculated based on rainfall data obtained from BMG Rote Ndao ., Ci = coefficient of runoff or surface flow of soil cover types, Ai = land area with soil cover type i (obtained from land cover maps of landset images from LAPAN and BPS and Bappeda of Rote Ndao Regency)

Note: Lubis and Terunajaya (2013) explain that for I = rain intensity will be calculated using the Mononobe formula where shortterm rain data in hours is not available where only daily rain data is available so that the calculation of rain intensity analysis uses the following formula:

, where : $I = \frac{R24}{24}\left(\frac{24}{t}\right)^{2/3}$

I = rainfall intensity (mm/hour), R24 = maximum rainfall in 24 hours (mm), t = duration of rainfall (hours).

Water Loss due to Evapotranspiration

According to Marwadi (2012), 80 to 90 percent of the rainfall that falls on agricultural land is lost to be re-evaporated as evapotranspiration, and only about 5 percent is utilized by plants. Therefore, evaporation was assessed as a loss of 80 to 90 percent of the water required by the plants in this study. For the calculation of evapotranspiration, the Penman technique can be used, while the crop coefficient can be seen in the FAO guidelines in irrigation standards, as shown in the following:
ETcrop = kc ETo .... (4)

ETcrop = Plant evapotranspiration, kc = crop coefficient, ETo = constant evapotranspiration.

Water input that falls into the catchment area undergoes a process of loss as runoff and evapotranspiration but some infiltrates into the soil based on soil type and land cover as follows:
Subsurface Water Input as Infiltration

Infiltration = x I x A .... (5)

= Infiltration coefficient
I = Rain intensity
A = Rain catchment area

Table 1. Soil Permeability Velocity Value.

No	Type of soil	Soil Permeability Speed (m/s)
1	Clay	< 10-9
2	Sandy Clay	10-9 - 10-8
3	silty clay	10-8 - 10-7
4	Silt	10-8 - 10-7
5	Very Fine Sand	10-6 - 10-5
6	Fine Sand	10-5 - 10-4
7	Rough sands	10-4 - 10-3
8	Gravel Sand	10-3 - 10-2
9	Gravel	> 10-2

Source : Verruijt 1970 (in Pungut and Widyastuti (2013).

Table 2. Value of C (coefficient of land use/landuse runoff) with the Rational Method

No	Landuse/ Type of Surface	Types of Land Cover	Range of C value
1	Downtown business	Shopping center	0.70 to 0.95
2	Heavy industrial	Heavy Industry	0.60 to 0.90
3	Multi-residential units, attached	Residential Complex	0.60 to 0.75
4	light industrial	Light Industry	0.50 to 0.80
5	Neighborhood businesses	Home Business	0.50 to 0.70
6	Cultivated lands with loamy soils	Loamy Agricultural Land	0.40 to 0.45
7	Suburban residential	suburbs	0.25 to 0.40
8	Playgrounds	Playground	0.20 to 0.35
9	General unimproved lands	Vacant land	0.10 to 0.40
10	Parks and cemeteries	Gardens and cemeteries	0.10 to 0.25
11	Woodlands with sandy soils	Forest with sandy soil	0.10 to 0.15

Source: Indarto,(2012).

Results and Discussion
Profile of Dryland Commodities in the Research Area

Source: BPS Rote Ndao Regency (2021)
Figure 1. Map of the Rote Ndao region of NTT

As reported by the NTT Central Statistics Agency (2013), NTT currently has an area of 3,691,421 hectares consisting of 3,491,130 hectares of dry land and 200,291 hectares of wetlands spread over several different islands. On Rote Ndao Island, the distribution of agricultural land is divided into two categories, namely wet land and dry land. Wetlands reach 17,242 ha or 8.61 percent of the total land area, while dry lands reach 76,683 ha or 2.20 percent of the total land area. The physiography of the terrain, which ranges from bumpy to wavy to hilly or gentle, and the type of soil dominated by three orders, namely Entisols, Inceptisols, and Vertisols, distinguishes NTT from other areas. Dry land soil fertility is naturally very low, and is characterized by low soil organic matter content,

There are four climate types in the study area: climate type D3 (three to four wet months and four to six dry months), climate type E3 (three to three wet months and four to six dry months), and climate type E4 (three to three dry months). wet months and four to six dry months). up to six wet months and more than six dry months). Dry land in the study area has a dry climate. The distribution and intensity of rainfall in dry land is irregular and unpredictable, as shown by Oldeman (2017), so that crop failures often occur in these locations. Due to limited water resources, water surplus occurs only in the wet months (December, January/February), with the rest of the year marked by a water deficit.

The dry land environment also has a comparative advantage that can be used to produce various superior agricultural commodities, including food crops and plantations as well as animal husbandry, forestry, and even inland fisheries. In addition, agricultural land productivity, and more generally the development of land productivity, has increased in various food crop commodities, including rice fields and dry land.

According to Rote Ndao Regency Agricultural Statistics data (2018), various plantation commodities are produced in Rote Ndao, including coconut, cashew, kapok, areca nut, jatropha and lontar palm trees, the latter of which has the largest planted area, which is 16,575.5 Ha. . This is consistent with the large number of micro-enterprises in Rote Ndao that process sap from East Rote with a planted area of 3,420 hectares, followed by West Rote with a planted area of 3,160.5 hectares, and finally in Central. Memorize. More specific information on the plantation subsector in Rote Ndao can be found in the following document:

Table 3. Plantation Plant Area by District and Plant Type in Rote Ndao Regency (ha) in 2018

No	districts	Coconut	Cashew	Kapok	Distance	betel nut	throw
1	Southwest Rote	496.75	70.05	0.86	15.75	35	1,001,50
2	Northwest Rote	831.5	150	95	35.15	7.05	3160,50
3	Lobalain	918.05	246.75	253.23	20.8	7.85	2,288.50
4	Central Rote	401.75	141.5	8.85	20.05	11.5	1,033.52
5	South Rote	701.5	140.5	10.65	130.5	6.55	632
6	New Beach	452.5	95.5	380.65	50	-	2,034.00
7	Eastern Rote	302.75	202.5	61.75	25	11	3,420.00
8	Landu Leko	65.75	121	25	20	1.35	1,286.00
9	Western Rote	541	177.5	25.75	135	12,151	1,684.23
10	Ndao Nuse	88.25	-	-	-	-	35.23
Rote Ndao Kabupaten County		4,799,80	1,345,30	861.74	452.25	92.451	16,575.40

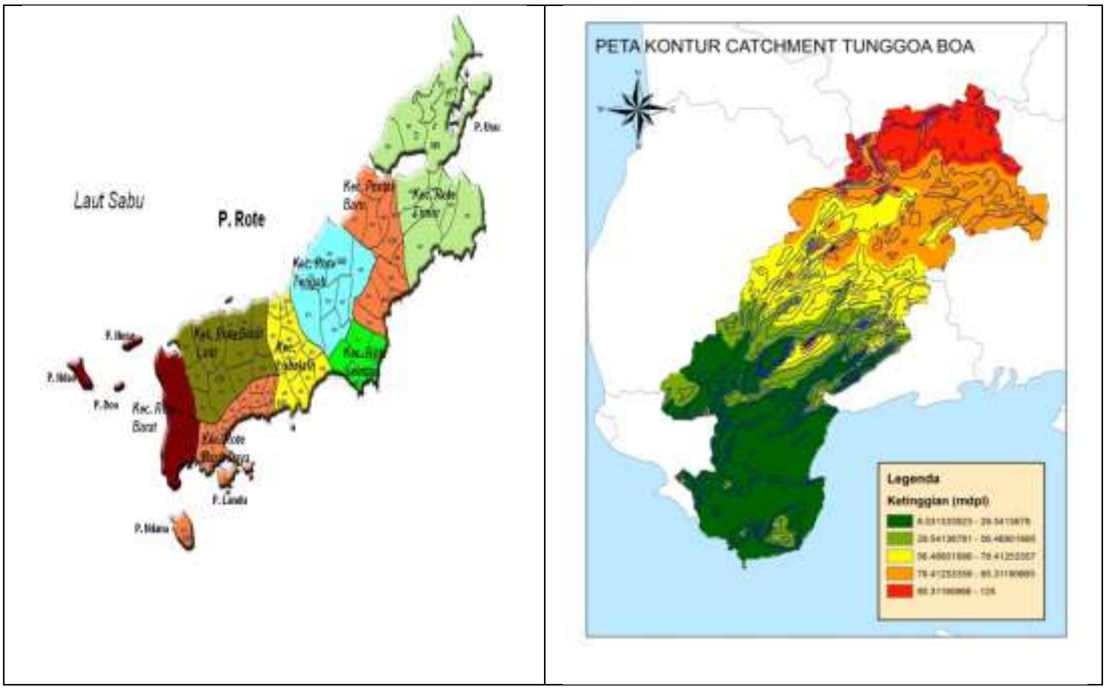
Source: Central Bureau of Statistics of Rote Ndao Regency (2019)

The Cactation Research Area is experiencing water shortages, causing concern.

The province of East Nusa Tenggara, and in particular the Rote Ndao Regency, is classified as a "dry" area by the United Nations. Rainfall occurs only for brief periods of 3 to 4 months of the year, with the remainder of the year dry. In addition, short periods of rain have a detrimental quality for agricultural development to meet global food demand. As a result of the distribution and duration of rainfall, temporary drought scenarios known as dry seasons and saturated soil situations known as waterlogging are common. The construction of dams or reservoirs is needed to overcome these obstacles.

Dams built in semi-arid areas will be able to fully contain water during the rainy season and can then be used for various purposes during the dry season. Nationally, the rainy season in NTT lasts for four months (November/December to February/March), while the dry season lasts for eight months (March/April to October/November).

During the dry season in the study area, the reservoir is used to meet the water needs of local residents, livestock, and other animals in nearby settlements. People living in areas that do not have a rainy season do not depend on water reservoirs to meet their needs. To achieve the above requirements, the required reservoir capacity must also take into account water loss through evaporation in infiltration wells (ponds) at the bottom and walls of the well or pond, as well as provide space for sediment to accumulate. The geographical conditions and topographical characteristics of the Boa Tunggaoen Tank Area are described in detail.



Picture. 2. Geographical Map of the Location and Topography of the Tunggaoen Boa Cactment Area.
Source: BPS Rote Ndao Regency (2021), and LAPAN Map (2015).

According to the map above, the research site is located on the southernmost promontory of Rote Island between 10 degrees 25' and 11 degrees South Latitude and 121 degrees 49' to 123 degrees 26' east longitude, with the following limits: 10 degrees 25' - 11 degrees South latitude, 121 degrees 49' to 123 degrees 26' East Longitude, and the boundaries are as follows: To the north it is bordered by the Sawu Sea, while to the east it borders the Sawu Sea. The Pukuafu Strait separates it from other countries, which in the west is bordered by the Savu Sea and in the south by the Indian Ocean. Located on a headland, this watershed receives westerly monsoons at the start of each rainy season, causing clouds to shift and causing the rainy month to shift to December or January, while easterly winds blow from March to April. and May, no more rain until November. This is corroborated by BMG data from Rote Ndao Regency (2015), which shows that based on rain data in Rote Ndao Regency, it only rains three to four months per year, from December to March to be exact.

The topography of the water catchment area of the study area is 2,599.33 ha, with an elongated position from upstream to downstream with a flat distance of approximately 3000-5000 m, or equivalent to a slope of 2 percent with wavy conditions, and an elongated position. from upstream to downstream with a flat distance of approximately 3000-5000 m, or equivalent to a slope of 2 percent with wavy conditions. As a result of the waves, there is a slope of up to 45 percent over short distances, and the wave slope is often 15-250 percent with alternating flats and basins. When viewed from the topographical features of the Tunggaoen Boa coastal area, there are four main troughs or basins that stretch from upstream to downstream in the area. At an altitude of 103 meters above sea level, The highest elevation in the catchment area is at the location of the mbore water tank that will serve the drinking water needs of the Sedeoen community, particularly the hamlets of Bunioen and Sedeon, and the lowest elevation is at 0 meters above sea level, or sea level, in the villages of Tunggaoen and Boa, which are located downstream of the catchment area.

According to Yunanto (2007), slopes are classified as follows: Grade 1: 0 – 8 percent (flat), Grade 2: 8 – 15 percent (slope), Grade 3:15 – 25 percent (slightly steep), Grade 4: 25 – 45 percent (weight), and Class 5: greater than 45 percent (very tall) (very steep). As a result, the topography at the Tunggaoen Boa watershed research location is classified as steep slopes in the upstream or peak areas, flat categories in the middle and downstream areas of the watershed, and undulating conditions, which has the potential to withstand or reduce the amount of surface runoff of rainwater entering the sea. According to Dewi et al. (2012), the greater the value of the slope, the less possibility of water entering the soil (infiltration), so that the volume of surface runoff is greater and the possibility of erosion is greater. Erosion is exacerbated by surface runoff, which is a major contributor.

Availability of Water Resources.
Calculation of Annual Inflow/Input (Water Enters the Tunggaoen Boa Cactment Area).

The results of the calculation of the input or volume or the amount of rainwater that enters the catchment area of Tunggaoen Boa are as follows:

Table 4. Annual, Monthly and Maximum Rainfall Data for 10 (ten) years in Rote Ndao Regency, NTT.

Rainy Year	**annual CH(mm)**	**Monthly Average (mm)**	**CH max (mm)**	**Rainy Date**
2005	1026.6	85.55	85.1	March 08, 2005
2006	1524.5	127.04	116.3	January 13, 2006
2007	1369.2	114.10	77.9	02 March 2007
2008	1921.7	160.14	139.1	04 January 2008
2009	1239.3	103.28	90.8	January 11, 2009
2010	1820.1	151.68	87.1	January 17, 2010
2011	2167.5	180.63	74.0	08 January 2011
2012	1402.7	116.89	101.2	March 13, 2012
2013	1849.2	154.10	106.0	03 March 2013
2014	1257.5	104.79	65.6	December 31, 2014
Total 10 years	15578.3	1298,19	146.6 (2015)	
Average	**1557.83 mm**	**129.82 mm**		**R24 max = 139.1 mm**
Total catchment area	**2559,3278 Ha**			

Source: BMKG data for Rote Ndao Regency 2015.

The area is classified as having moderate rainfall based on the data in the table above which shows an average annual rainfall of 1557.83 mm/year for the last 10 (ten) years. The average monthly rainfall is 129.82 mm/month which is in the range of 100-200 mm/month, so it is a moderate rain location. For this location, Oldeman's (1975) temperate climate classification, which includes a monthly rainfall of at least 100 millimeters and less than 200 millimeters, was used (Agus and Ruitjer, 2004). There was 139.1 millimeters of rain on January 4, 2008, the heaviest day ever recorded for a daily maximum. The heaviest rainfall data is used to predict the amount of surface runoff that will occur during the construction of water infrastructure and new buildings. East Java, Bali, and Nusa Tenggara are said to be dry because they experience a water deficit for six months or more. Therefore, in planning an activity or development including rainfall data, reliable data information is needed. Sisworo and Atiyah (2014) found that by building a computer-based Groundwater Availability Information System, information on water availability becomes more practical and fast, precise and accurate. The graph below illustrates the relationship between monthly rainfall and the amount of water entering the catchment. information on water availability becomes more practical and fast, precise and accurate. The graph below illustrates the relationship between monthly rainfall and the amount of water entering the catchment. information on water availability becomes more practical and fast, precise and accurate. The graph below illustrates the relationship between monthly rainfall and the amount of water entering the catchment.

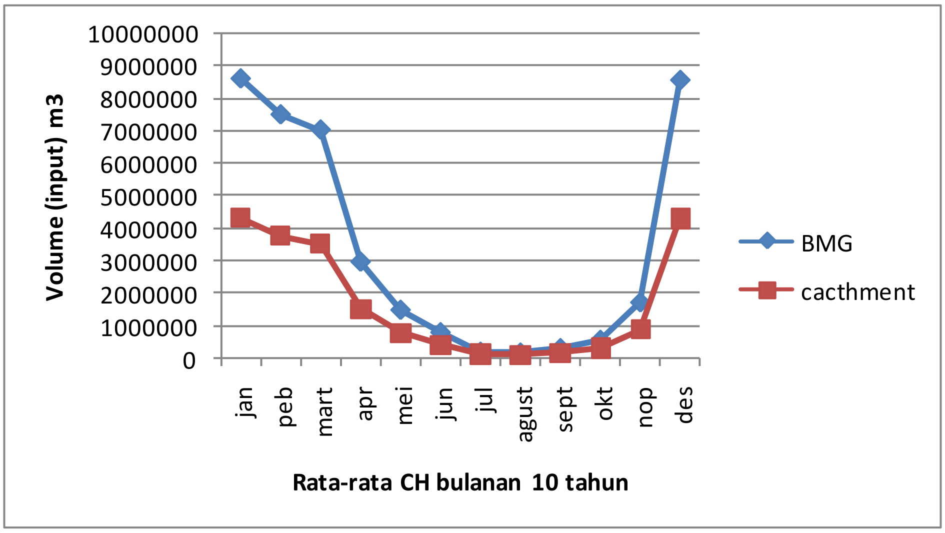


Figure 3. Graph of Monthly Rainfall and Input Volume.
Source: Researcher's calculation results (2021).

Runoff Debit Calculation Results with Monthly or Monthly CH Average

In calculating surface runoff that occurs every month in the catchment area of Tunggaoen Boa, West Rote District, NTT, the rainfall data regarding rainfall, duration of rain, frequency of rain events, and the results of calculating the intensity of rain are the basis for the calculation, so the final result of calculating the volume of surface runoff is /runoff each month can be seen in the table below:

Table 5. Recapitulation of Monthly Runoff Average Calculation Results for 10 (ten) years (2005-2014).

Month	Monthly CH(mm)	Amount of Runoff (m3/s)	duration (minutes)	Rainy Day (day)	Amount of Runoff (m3/month)	Peak Discharge Runoff = Qp (m3/month
January	335.79	1,259	47.9	19.1	4,145,190,688	4,145,191
February	292.7	1.576	27.8	16.5	2,601,700,554	2,601,701
March	274.45	1,613	24.5	16.3	2,318,684,488	2,318,684
April	115.92	466	43.6	10.3	753.590.792	753.591
May	58.14	429	17.5	4.8	129,681,786	129,682
June	31.19	93.23	64	2.6	55,846.401	55,846
July	7.76	27.97	51	1.3	6,675,390	6.675
August	6.73	37.29	32.5	0.8	3,490,400	3,490
September	12.06	0.00	0	1	-	-
October	22.03	0.00	0	1.8	-	-
November	67.14	0.00	0	4.7	-	-
December	333.92	1.147	54.9	18	4,079,358,051	4,079,358
Amount	**1557.83**	**6,647**	**40**	**89.7**	**14,094,218,548**	**14,094,219**

Source: Researcher Calculation Results (2021).

The Tunggaoen Boa watershed experiences an annual runoff of 14,094,219 m3/year, according to the table above (35.35 percent of the total inputs that enter the watershed). In the Tunggaoen Boa watershed there are only 6,785,417 m3/year based on BMG rainfall data, so the actual conditions in the area must be based on rainfall data in the field (48.14 percent BMG). Due to the large amount of water lost when it rains, the large amount of surface runoff is an environmental hazard in the form of air, erosion, and water flow into the sea that damage marine ecosystems, especially coastal communities. ,,,. Kaharudin, et al. (2014) found in their study in the Hulu Batang Gadis watershed that between 2008 and 2012, the erosion rate increased by 20.26 percent, which they attributed to runoff/surface runoff. In Purboseno (2013), he stated that the damage to the air catchment area and the entry of forest areas into building areas will cause an increase in flood discharge and drought in the downstream area. This is supported. As a result, water resources are becoming scarcer.

Water Loss due to Percolation

The results of the calculation of the amount of percolation that occurred in the catchment area of Tunggaoen Boa, West Rote District, NTT are as follows:

Table 6. Soil Type and Infiltration Volume from the Tunggaoen Boa Percolation Catchment Area (m3/year).

No	Type of soil	%	Area of Ha	Infiltration Coefficient (%)	Infiltration Volume (m3/year)
1	Q1 = Pleistocene or coral limestone (coraline limestone)	94.37	2047,46	30	5,434,285
2	Qa = Alluvium (Holocene)	1.88	48	15	54.130
3	Sand = land of sand	3.75	96	65	467,877
	Total Area	**100**	**2559.32**	**31.03**	**5,956,292**

Source: Bandung Geological Agency (2015) and Calculation Results (2021).

The table above shows that the Tunggaoen Boa watershed with an area of 2,559.32 hectares is 31.03 percent (or 5,956,292 m3/year) of the total volume of water entering the detention zone of 19,194,958.50 m3/year annually. On land type Q1 = Pleistocene or Coral Limestone with an area of 2047.46 Ha (94.37%) of the total catchment area, 5,434,285 m3/year of total rainfall as water input into the catchment area of 19,194,958.50 m3/year is lost due to infiltration. Types of sedimentation and sand have different infiltration capabilities, namely Qa = Alluvium (Holocene) covering an area of 48 Ha (1.88 percent) contributing to infiltration of 54,130 m3/year and Sand = sandy soil 96 Ha (3.75 percent) contributing to infiltration of 467,877 m3/year, where soil type Sand = loss of sandy soil due to infiltration is much greater than soil type Qa = Alluvium (Holocene) or sedimentation. This is because sandy soils absorb water faster than alluvial or sedimentary soils, which is why this happens.

For plants, infiltration is very important to replenish soil moisture content and replenish subsurface water reserves as stock for the dry season. As stated Mawardi (2012), the amount and rate of water that seeps into the ground has an impact on the availability of water (water) for plants, groundwater reserves, and surface runoff. In the perspective of Sudarmanto, et al. (2013), the Kreo sub-watershed is still quite good at responding to rain as surface runoff, meaning that the possibility of infiltration is still strong, where water reserves continue to increase when it rains. Sartohadi (2012) stated that the pore volume of the soil affects the amount of infiltration, this factor is related to the soil pores, where the larger the pore, the greater the infiltration capacity. Support for this claim stems from the fact that soil structures can accelerate permeability, with increasing space between structures increasing soil permeability rates. Physical differences between dry and flooded soils have been noted by Rahayu et al (2014), and in general, paddy soils are denser than dry soils.

Water Needs and Population Storage

The calculation of water needs includes two needs, namely water needs for residents and water needs for agriculture. The calculation of water demand uses the sub-district analysis unit, for reasons of the availability of existing basic data, namely in sub-district units.

The standard of clean water needs for the needs of the population can be implemented as follows:

Table 7. Standards of Water Consumption for Population Needs

No	City category	Number of Population (people)	Standard Water Needs (Lt/Soul/Day)
1	Metropolis	>1,000,000	190
2	Big city	500,000 – 1,000,000	170
3	medium city	100,000 - 500,000	150
4	Small town	20,000 – 100,000	130
5	District city	3,000 – 20,000	100

Source: Directorate of Sanitary Engineering. Directorate General of Human Settlements (2010)

The capacity required for a reservoir can be formulated as follows:

Vn = Vµ + Ve + Vi + Vs

Where:

Vn = total capacity required by a village/region (m3)

Vµ= volume of life to serve various needs (m3)

Ve = the amount of evaporation from the well during the dry season (m3)

Vi = amount of infiltration through the bottom, walls and body of the reservoir during the dry season (m3)

Vs = space reserved for sediment (m3)

In determining the total capacity of a reservoir, the volume/discharge of available water (Vh) and the topography's ability to hold water (Vp) must be considered. If the available water or topographic capacity is small, the reservoir must be designed with a capacity that is smaller than the maximum demand for a village or region.

Availability of water, water that enters the reservoir is surface water from all rainfed areas and effective rainwater that falls directly on the surface of the well or pond. The amount of water that enters the wall is formulated as follows:

Vh =$\sum V$j + 10. Act. j or Vh$\sum R$= $\sum V$j

Where:

Vh = volume of water that can fill the reservoir well during the rainy season (m3)

Vj = monthly flow in month j (m3/month)

$\sum V$j = total flow during the rainy season (m3)

Rj = monthly rainfall in month j (mm/month)

$\sum R$j = total rainfall during the rainy season (mm), the dry season rainfall is neglected

Akt = surface area of pond/dam well (ha)

Water volume Vh = is the maximum amount of water that can fill the reservoir well. Therefore, the available water must be compared with the required holding capacity in determining the total capacity or reservoir height.

The volume of water that can fill the pond pond.

The volume of water that can fill a reservoir well during the rainy season is for example:

$\sum V$j = 1,737,293 m3

Akt = 4.1 ha

$\sum R$j = 896 mm

Vh = 1,737,293 + (10 x 4.1 x 896)

= 1,774,029 m3

Based on the results of the water balance, it is found that the best area that can be developed is by planting rice-paddy-palawija with a planting period starting in mid-December with a water requirement of 1.12 lt/sec/ha or 96.77 m3/hr/ha with an area of potential of 125.18 ha. Where the area to be irrigated is 76.6 ha, then the need for irrigation water is 7.412 m3/hr.

Meanwhile, from the calculation results for water needs, it is obtained as follows:

Table 8. For Types of Population and Agricultural Needs

No	For the type of water requirement	Water requirement (m3/hr)
1	Resident	1.383
2	Agriculture consists of: a. Irrigation b. farm	 7.412 0.37
	Total water requirement (Qu)	8,794.37

Source: processed by researchers (2021)

The total for the live reservoir (Vu) is mathematically as follows:
Vu = Jh x Qu
Where:
Jh = the number of days during the dry season, which is practically = 8 months x 30 days = 240 days.
Qu = water demand for residents and agriculture (m3/day).
Based on the study by entering the above quantities, the total water requirement for the reservoir is as follows:
Vu = 240 x 8,794.37
= 2,110,649 m3

Meanwhile, water requirements for livestock activities include large livestock and poultry where the standard water requirement for large livestock is 25 liters/day/head, while for poultry 2.5 liters/day/head (Department of Agriculture in Siti Nurasiyah, 2015). calculation of water needs for a farm can be presented in the following table:

Table 9. Water Needs for Livestock

No	Type for livestock	Quantity (tail)	Water requirement for Livestock (m3/hr)
1	big cattle	12	0.29
2	Poultry	33	0.08
	Total water requirement		0.37

Source: processed by researchers (2021)

Infiltration in Catchment Area,

The results of the calculation of the amount of infiltration as water that seeps into the soil in the catchment area of Tunggaoen Boa are as follows:

a. Infiltration Calculation with Rational Method

The results of the calculation of the amount of infiltration with a value of C (landuse runoff coefficient) using the Rational Method in the Tunggaoen Boa Cactment Area. into the soil when it rains I = 117,223.29 m3/hour, meaning that if it is calculated a year, the volume of infiltration that occurs is 40 minutes of rain, resulting in an infiltration of 7,596,069 m3/year (39.57% of the total input into the catchment area) and when compared with the BMG input, it is15,776,550 m3/year BMG data. The largest volume of infiltration is in the use of scrub land because this land is also the largest land (80.32%) of all types of land use in the catchment area of Tunggaoen Boa.

b. Infiltration Calculation with Horton's Model Method

Infiltration calculation results (see Appendix 5. Table 48. Calculation of Infiltration Rate Using the Horton Model in the Tunggaoen Boa Catchment Area in West Rote District, NTT, 21 to 29 October 2015). Based on the calculation table above, it is known that the amount of infiltration that occurs is 18,687,894 m3/year (46.87% of the total BMG rain input) or the actual volume of infiltration that occurs in the catchment area of Tunggaoen Boa is 8,996,352 m3/year.

c. Calculation of Infiltration with Natural Affix Model Method

The results of the calculation of the amount of infiltration using the natural recharge model in the Tunggaoen Boa catchment, show that the results of the calculation of infiltration using the natural recharge method, the infiltration that occurs is 17,278,174 m3/year (43.34% of the total BMG rain input) or infiltration that occurs in the catchment area of Tunggaoen Boa is 8,317,713 m3/year. The highest infiltration occurs in January, followed by December, February, March and April, it can be concluded that the greater the rainfall, the more water infiltrates into the soil. This is supported by Muliranti (2012) that areas with high rainfall and large area will have high availability of meteorological water and vice versa. Therefore, The size of the area greatly affects the amount of water availability, assuming the amount of rain that falls on an area is the potential of water that can be used by the local community for a certain need, so in this case the area is an important factor in determining the availability of water for water needs in an area. The Ministry of Forestry (2012) through its research agency stated that the watershed ecosystem (DAS) in recent decades has experienced a decline in environmental quality such as frequent flooding in the rainy season and drought in the dry season, sedimentation, decreased water quality, lowering of ground water level which can cause erosion. speed up the process of seawater intrusion,

Mechanical Vegetative Conservation

Planting vegetation and using appropriate tillage methods to select crop species and tillage based on the following criteria is an important part of mechanical vegetative conservation. Types of plants that are able to thrive in soils with low water content should be prioritized. This is because the activity site only receives three to four months of rainfall, and the soil consists of limestone which is prone to erosion. Plants are able to capture a lot of light because they have a high leaf density. As a result, water penetration into the soil is increased and surface runoff is reduced. The strong roots ensure that the stems can stay strong in windy and sloping situations, enabling the fruit they produce to be of great economic value. To maximize land conservation and community economic well-being, it is possible to combine different plants. Credit terraces with sloping to wavy soil surfaces with a slope of 3-10 percent and a distance between terraces of 5-12 meters are recommended for land preparation by Kustamar (2009). Soil with a slope of 10 to 50 percent, the average distance between bunds and an average of 10 m, is used to construct the Gulud terraces. Drainage channels, terrace reinforcement, and waterfall structures are required for bench terraces with a slope of 10% to 30%. Plant paths and individual terraces can only be built on land with a slope of 30 to 50 percent and little rainfall if the terraces are used for individual plants or trees as planting holes in the ground. Credit terraces with sloping to wavy soil surfaces with a slope of 3-10 percent and a distance between terraces of 5-12 meters are recommended for land preparation by Kustamar (2009). Soil with a slope of 10 to 50 percent, the average distance between bunds and an average of 10 m, is used to construct the Gulud terraces. Drainage channels, terrace reinforcement, and waterfall structures are required for bench terraces with a slope of 10% to 30%. Plant paths and individual terraces can only be built on land with a slope of 30 to 50 percent and little rainfall if the terraces are used for individual plants or trees as planting holes in the ground. Credit terraces with sloping to wavy soil surfaces with a slope of 3-10 percent and a distance between terraces of 5-12 meters are recommended for land preparation by Kustamar (2009). Soil with a slope of 10 to 50 percent, the average distance between bunds and an average of 10 m, is used to construct the Gulud terraces. Drainage channels, terrace reinforcement, and waterfall structures are required for bench terraces with a slope of 10% to 30%. Plant paths and individual terraces can only be built on land with a slope of 30 to 50 percent and little rainfall if the terraces are used for individual plants or trees as planting holes in the ground. the average distance between bunds and an average of 10 m, was used to construct the Gulud terraces. Drainage channels, terrace reinforcement, and waterfall structures are required for bench terraces with a slope of 10% to 30%. Plant paths and individual terraces can only be built on land with a slope of 30 to 50 percent and little rainfall if the terraces are used for individual plants or trees as planting holes in the ground. the average distance between bunds and an average of 10 m, was used to construct the Gulud terraces. Drainage channels, terrace reinforcement, and waterfall structures are required for bench terraces with a slope of 10% to 30%. Plant paths and individual terraces can only be built on land with a slope of 30 to 50 percent and little rainfall if the terraces are used for individual plants or trees as planting holes in the ground.

Conservation in a constructive way

Both infiltration wells and infiltration wells can be used for conservation purposes. There are two types of infiltration wells and wells that can be used depending on the terrain of the area. When vegetative methods are not an option because the area concerned must be preserved, such as an open area or livestock area, this is the primary choice.

Wells for water absorption and reservoirs for water absorption

Infiltration wells are structures designed to collect and distribute rainfall deep into the earth, according to the findings. In addition to storing excess surface water, infiltration wells can also be used to improve the quality and quantity of groundwater as well as create a barrier to prevent saltwater intrusion. Kustamar (2009) states that the size of the infiltration well is determined by several factors, including the area of the rainwater reservoir, which is defined by Kustamar (2009) as the land where rainwater will be accommodated in the infiltration well; roof area and yard area; and rain properties. When it rains, it is necessary to dig as many infiltration wells as possible to raise the water table because of the coefficient of soil permeability, which is the ability of the soil to pass water per unit time. Infiltration wells are river structures that have the same shape as reservoirs or dams with a height of less than 1 meter that are used to absorb surface runoff water that collects in river channels. Consequently, tributary channels starting in vital river basins are desirable locations for constructing reservoirs. The planned infiltration well position is depicted in the diagram. The volume and porosity of the foundation rock and the bottom of the reservoir are very important for the success of the infiltration basin. The infiltration capacity is reduced when the rock is less porous, whereas the hydraulic impact of the reservoir is increased when it is too porous A tributary channel that starts in a vital river area is a desirable location for constructing a reservoir. The planned infiltration well position is depicted in the diagram. The volume and porosity of the foundation rock and the bottom of the reservoir are very important for the success of the infiltration basin. The infiltration capacity is reduced when the rock is less porous, whereas the hydraulic impact of the reservoir is increased when it is too porous A tributary channel that starts in a vital river area is a desirable location for constructing a reservoir. The planned infiltration well position is depicted in the diagram. The volume and porosity of the foundation rock and the bottom of the reservoir are very important for the success of the infiltration basin. The infiltration capacity is reduced when the rock is less porous, whereas the hydraulic impact of the reservoir is increased when it is too porous

Water Conservation Model Innovation in Catchment Area

The Water Conservation Innovation Model with the additional integration of reservoirs, infiltration wells and Forest/Vegetation infrastructure, is an innovation that replaces the previous existing model that only relies on reservoir infrastructure, or infiltration wells, or only vegetation.

The existing model of water resource conservation that relies on the ability of natural land is modified with additional infrastructure and vegetation that is able to accommodate water both above the ground surface and subsurface reservoirs so as to overcome water shortages/deficits. The results of multiple regression analysis with minitab software are as follows:

Regression Analysis: infiltration versus CH; KL; PR; PMK; SB; Emb; Htn; SR

The regression equation is

infiltration = - 0,292 + 0,367 CH + 0,020 KL + 0,021 PR + 0,057 PMK + 0,014 SB - 0,055 Emb - 0,380 Htn + 0,40 SR..... (8.1)

$Y = a + b1x1 + b2X2 + b3X3 + b4X4 + b5x5 + b6x6 + b7x7 + b8x8$ ....(8.2)

with statistical analysis function $Y = f(x1, x2, x3, x4, x5, x6, x7, x8)$

where,

Y = volume of water resulting from conservation of water resources; a = intercept.; b1, b2, b3, = regression coefficient.; x1 = CH (rainfall); x2 = KL (field garden); x3 = PR (meadow); x4 = PMK (settlement); x5 = SB (bush); x6 = Emb (reservoir); x7 = Htn (forest); x8 = SR (infiltration well).

x6,x7,x8 = (ISREV) is the addition of Reservoir, Infiltration Well and Forest Infrastructure to accommodate and absorb water into underground reservoirs as additional storage. Calculation of the volume of water that can be accommodated and absorbed into the soil to overcome water shortages/water deficits is -- 5,851,397 m3/year. Simultaneous test results (overall) show that all independent variables (x1-x8) together have a very significant effect on infiltration (Y). This is indicated by the calculated F value (1.33633E+13) > F table (5981.07) with a probability value ($P < 0.01$). Test partially (each independent variable) if T count > T table or $P < 0.05$ then there is an effect of the independent variable on the dependent variable.
Changes in the value of x or land conversion cause a decrease in rainfall, which in turn changes infiltration. Depending on the x function, each change will result in a decrease or increase in the amount of infiltration (influence variable). To increase the amount of water that can be accessed in the Tunggaoen Boa watershed, a mathematical equation is used to anticipate the design results of a water resource conservation model that uses infiltration. This equation is based on the results of the analysis. Geospatial information systems (GIS) can be used to determine where infrastructure should be built based on factors such as terrain (wavy) and flow direction (spread downstream or not at all). Therefore, it is not recommended that the main reservoir (cekdam) has only one outlet point, but the distribution of reservoirs and infiltration wells is made using the geographic model generated by the map overlay. According to Tamelan and Harijono (2019), tourist destinations need a lot of water to help the local economy grow and meet tourist demand.

The results of the analysis of infrastructure needs in the design of the water resource conservation model in the catchment area of Tunggaoen Boa are as follows:
1. In order to infiltrate/absorb runoff/runoff into the ground, it is necessary to have the highest rainfall data for the last 10 years, which is 139.1 mm or 0.1391 m, with the aim that the next rainfall can be accommodated by the said infrastructure, and the catchment area 2,559.33 Ha.
2. The results of the analysis of the amount of input 3,615,668 m3/when it rains the most.
3. The results of the analysis of the amount of infiltration 46.87% BMG from the input is 1,694,663 m3/when it rains.
4. The results of the analysis of the amount of surface runoff/runoff is 35.35% of the input, namely 1.278.138 m3/when it rains the most.

The first step of the calculation approach is as follows:
1. Based on the catchment area map overlay, there are potential 7 (seven) reservoir locations, meaning that the volume of each reservoir is 1,278,138 m3 divided by 7 (seven) reservoirs, so the volume of water that must be accommodated by the reservoir is 182,591 m3/reservoir. The size of the reservoir is designed to be 100x150x12.5m, resulting in a volume of 187,500m3/reservoir multiplied by 7 (seven) reservoirs to 1,312,500 m3 > 1,278,138m3/during heavy rain, meaning that the reservoir volume is met in anticipation of runoff, or Zero Runoff.
2. Based on the calculation of the infiltration rate in the catchment area of Tunggaoen Boa, with Andosol soil type (Gamping Coral) the infiltration rate of 11.67 cm/hour was obtained. The height of the reservoir is 12.5m or 1,250cm, so it takes 107 hours or 4.46 days to infiltrate the water in the reservoir. This means that in 1 (atu) day the reservoir is only able to infiltrate water into the soil by 11.67 cm/hour multiplied by 24 hours so that it becomes 280.08 cm or 2.80 m/day. For this reason, the design of the infiltration pond requires a depth (t) of only 2.80 m.

Considering the ability of the location to place the reservoir infrastructure, namely 7 (seven) locations, the division is carried out, namely 4 (four) reservoirs for water absorption and 3 (three) reservoirs for surface water storage to meet the needs of agriculture and animal husbandry.

The second stage of the calculation approach is as follows:
1. To overcome the water shortage/water deficit that occurs at -5,851,397 m3/year, 4 (four) reservoirs are needed with a net size of 100 x 80 x 2.8 m, so the storage volume is 22,400 m3/reservoir. The largest average rain in a year (4 months namely January, February, March, December) is 69.9 rainy days. The calculation results show that the volume of water that can be absorbed from 4 (four) infiltration ponds for a year is 6,263,040 m3/year, > water storage deficit is -5,851,397 m3/year. This means that 4 (four) infiltration ponds are able to overcome the water deficit/water shortage in question.
2. The potential for making infiltration wells consists of 230 resident houses in the catchment area of Tunggaoen Boa, so there are potentially 230 infiltration well holes with a diameter of 1.5 x 2m in depth. For this reason, the calculation of the volume of water that can be absorbed is 78,779 m3/year. Meanwhile, if water infiltration only relies on infiltration wells, the largest runoff is 1,278,138m3/during heavy rains, 361,822 infiltration well holes must be required. To meet the need for water shortages/deficits of -5,851,397 m3/year divided by 343.53 m3/year/infiltration wells, 17,083 infiltration wells are needed.
3. The results of the calculation of water needs for agriculture which are still lacking are 152,650 m3/year and livestock 23,580 m3/year so that the total demand for agriculture and livestock that is directly used from reservoirs is 176,230 m3/year. The potential for the availability of 3 (three) reservoirs, the size of the reservoir reservoir volume is 58,743 m3/reservoir. The design size of the reservoir is 60 x 100 x 10 m, resulting in a water volume of 60,000 m3/reservoir or a total of 3 (three) reservoirs of 180,000 m3/year > agricultural and livestock needs 176,230 m3/year.
4. An additional 200 Ha of vegetation/forest land will produce a water volume of 1,002,600 m3/year.
5. Based on the calculation results, the total rainwater that can be harvested by infiltration ponds and infiltration wells and reservoirs is 7,524,419 m3/year > water storage deficit -5,851,397 m3/year. This shows that the additional model of reservoir

infrastructure and infiltration wells in the catchment area of Tunggaoen Boa can overcome water shortages/deficits to meet water needs.

Validation Model X6,x7,x8 = ISREV, as follows:

Based on the results of the validation calculations with the addition of 7 reservoirs, 230 infiltration wells and 200 Ha of vegetation/forest land, it will produce an additional volume of water in the Tunggaoen Boa catchment area of 6,952,979 m3/year > the volume required is 5,851,397 m3/year, so it meets the requirements.

Responsible and Implementing Model 1.

The Government of Rote Ndao Regency as the main person in charge, together with the local community, will immediately establish a RT/RW, especially a water resource conservation area. Furthermore, the Government prepares a budget and builds infrastructure for water resources conservation, consisting of 4 (four) infiltration ponds and 3 (three) reservoirs. Spatial location of the infrastructure (see Figure 8.1. ISREV Placement Design based on topography in the Tunggaoen Boa Catchment Area) below. The person in charge of maintenance is the government and the community of palawija farmers.

Conclusion

Based on the results of the research discussion, it can be concluded that the availability of water resources in the Rote Ndao tourism area relies on rainfall, but the undulating topography makes it difficult for many agricultural and residential locations to obtain clean water and agricultural water in meeting their needs and innovation of water conservation models in critical lands in tourism areas. This can be done by innovating models of infiltration wells, forest/vegetation and infiltration ponds as well as reservoirs in potential locations, namely the lowest elevation of the basin which contribute to anticipating over runoff and the potential for infiltration is quite large and good because the type of soil is more sandy silt, making it easier to accelerate infiltration/ absorption. This study recommends the design of infiltration ponds, reservoirs, infiltration wells, and vegetation that must be carried out by taking into account the potential for soil types, land use, topography, elevation, which can be used as locations for water infiltration into the soil. The types of plants and planting methods selected must go through a study with a review of land suitability, planting time, social and economic impacts.

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