

# 3D Model Animations of Artificial Recharge Wells in Resolving Fresh Water Quality Problems in Very Small Island (Case Study of Pari Island, Jakarta, Indonesia)

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**Abstract**— Artificial recharge wells was the technology to solve fresh water availability problems especially in small or very small islands. In small or very small islands the fresh water became scarce because of the size and structure of the islands, which caused sea water intrusion to ground water, was easy to be occurred. The artificial recharge wells was intalled, developed, and used in Pari island to tackle that problems. The measurements and analysis showed that the ground water in the island was tend to brackish, with the hope by this artificial recharge wells the people in that island will no longer difficult in finding source of fresh water. Because the importance of this research was significance in trying to solve one of the problems found in Small Island in Indonesia. so, it was needed to be modelled in 3D animations in order for researchers can study the work mechanism of the wells to improve and apply it for others region, and people will know about the technology itself. The making of 3D model animations was through series of stages and process, they were pre-production, production, and post-production. The making of this 3D model animations with the support of softwares, they were 3Ds Max, Adobe After Effect, and Adobe Premier.

**Keywords**— artificial recharge wells; fresh water; Pari Island; 3D model; animations

## I. INTRODUCTION

Indonesia consist of more or less than 17.500 islands, most of the islands are small islands. The definition of small island is the breadth less than 1000 square kilometers, and the tiny island is the breadth less than 100 square kilometers, also very tiny island with length around 1 kilometer or 2 kilometers and width around 500 meters [1]. Those kinds of islands are so many in Indonesia and usually with dense populated. With the dense populated of those islands marked that the needs fresh water were plenty. The size of small, tiny, and very tiny islands were the issues why they trouble with finding the source of fresh water, because those islands were surrounded with sea water so intrusion to the ground water will be easily occurred. That's why small islands in Indonesia were hard to find quality of fresh water below the surface. The taste of ground water in small island normally will be salty because of that intrusion [2] [3].

Peoples who live in small, tiny, and very tiny islands have to find the sources of fresh water especially for drinking and cooking. If they insisted to use of that ground water which tasted salty, the taste of beverages or foods will be bad. Usually they bought for gallon or bottled water which was brought from Jakarta (Capital city of Indonesia), because that drinking water have to be brought from other island so the cost to buy that water will be higher because of shipping cost [4]. Other way to consume fresh water from small island was to make wells that can collect water from the rain. Also there were the wells that had function as tanks to deposit the salt in the ground, so peoples took the water at the surface in that wells. With that method peoples in small island hoped that the water that tooked from the wells will not salty as sea water. Even with this method the taste of the water still would not good as normal fresh water which was referring to Indonesian Government regulations [5] [6].

TABLE I  
WATER CLASSIFICATION BASED ON SALINITY & DHL

CLASSIFICATION	SALINITY (%)	DHL ( $\mu\text{S}/\text{CM}$ )
FRESH	<0.5	<1000
BRACKISH	0.05 - 3	5000 - 15,000
SALTY	3 - 5	15,000 - 50,000
SEA WATER	> 5	> 50,000

The research question on this paper are there any solutions to get fresh water in small island without causing high cost to get that water? One of the solutions that researchers from Indonesian Institute of Sciences (known as LIPI) offered was by using artificial recharge wells (called as sumur imbuhan buatan or SIMBAT). The principle of this artificial recharge wells was simple where in rainy seasons (mostly regions in Indonesia the rainy seasons were high, because of tropical climate), the water from the rain was injected into the pipes which were placed in the ground of artificial recharge wells. Using artificial recharge wells technology that injected rain water were stored in the ground and blended with ground water existed before, by the time the salt that existed before in ground water will be pushed to the lower of the ground and the normal fresh water referring to Indonesian Government regulations will be existed in upper layer of the ground. The water in that upper ground which can be used as fresh water to be consumed daily [6] [7].

The small island or even included as very tiny island (the smaller size of the island, the harder to get the fresh water) that used as research object by putting, intalling, and testing of artificial recharge wells was in Pari island. With the length around 2 kilometers Pari island is part of Seribu islands and administrative in Jakarta Province, Indonesia [8]. The research was carried by researchers of Indonesian Institute of Sciences especially Research Center for Geotechnology. The choosen of Pari island as research object/location because beside it's very tiny island, in Pari island there is a base of Indonesian Institute of Sciences which has function as development and improvement of human resources capabilities of Research Center Oceanography. So, researchers team put and installed artificial recharge wells in the area of that Indonesian Institute of Sciences base [6].



Fig. 1. The location of Pari island in map



Fig. 2. Researchers from Research Center for Geotechnology – LIPI were doing research at artificial recharge wells installation

The installation of artificial recharge wells was not too complicated by using the pipes called as galleries which were connected one gallery to another. Through this galleries the rain water will flow into the recharge wells which had the function as container vessel. The rain water in recharge wells that will be used to neutralize salt and others contain in ground water. Finally the ground water can be taken and used as normal fresh water [6].



Fig. 3. Artificial recharge wells was intalled at LIPI base in Pari island

In Pari island when it's on dry seasons the measurements of ground water quality showed that the water would taste salty, results of that measurements showed in this graphic [6].



Fig. 4. The result from wells monitor in Pari island

The others parameter of ground water samples also were taken to strengthen the analysis and results that in Pari island was needed artificial recharge wells, in order to utilize ground water as fresh normal water by local people. The others parameter are shown by the following figure [6].

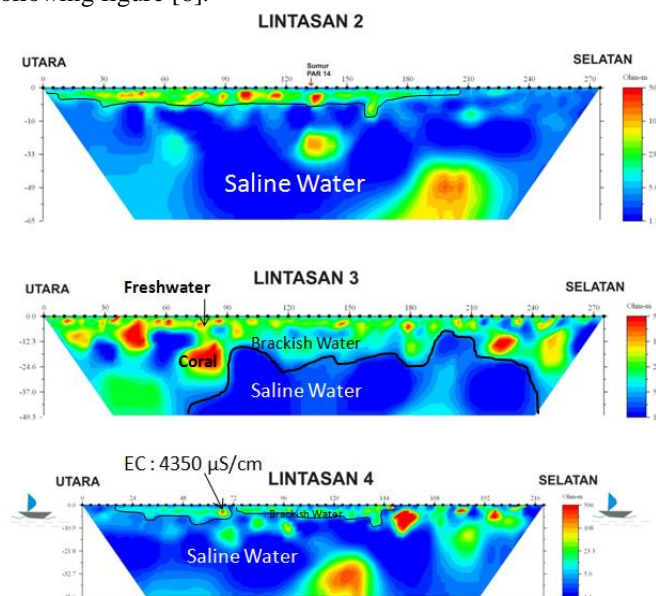


Fig. 5. The result from geoelectric measurement in Pari island

Based on the measurements and analysis on that data, can be concluded that ground water in Pari island was in salty or brackish condition. That's way the artificial of recharge wells hoped can solve the problems of fresh water availability especially in Pari island. So, people in that island will not trouble in finding fresh water resources. The availability of fresh water will affect level of healthiness, prosperity, and many things.

## II. METHODOLOGY

By using the pictures that have been drawn before in describing the details of artificial recharge wells design, process or mechanism of artificial recharge wells including the flow of water, level of salinity and geoelectric, seawater interface and intrusion. From those pictures were tried to be modeled in 3D. After the models with all the details and features have done, the next process was moving or animating those models based on the references (pictures and researchers interview). In making 3D model animations of artificial recharge wells was through 3 stages/phases they were pre-production, production, and post-production. Each of the the stages consisted of process as described below, and between the process were related and dependent to each others [9].

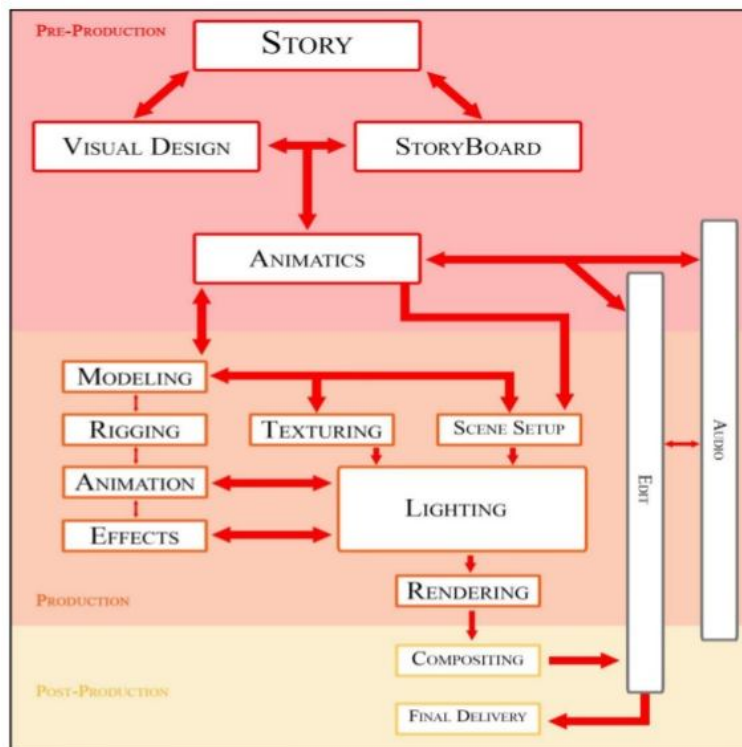


Fig. 6. The framework of methodology that used to create 3D model animations

Pre-production was stage to prepare everythings before making the models, the things that were needed to be prepared among them were the script or scenario as a story guidance in making animations, and story board as guidance to create models as representation of objects that were involved in artificial recharge wells. Production was stage to create models and all of details and features include the texture and lightning, also in this stage where the effects and animations were added in order to the models can move based on the story board. Post-production was stage to finish all the process to be compositing or rendering, video and sound editing, also to make sure that 3D model animations was being converted into the movie/video that can be watched on various media electronics or devices [10][11]. Each of this stages and process will be discussed below.

## III. RESULT & DISCUSSIONS

### A. The Definition of 3D (Three-Dimension)

Three dimensions (3D) model was the descriptions of the objects which were simulated in virtually. The 3D model created by using 3D softwares, different with two dimensions (2D) model which was originally created by hands. The 3D model from the start till the end is using computer programs which are dedicated to make 3Ds. 3D model also known as 3D computer graphics. 3D computer graphics are graphics that use a three-dimensional representation of geometric data that is stored in the computer for the purposes of performing calculations and rendering 2D images. So, 3D model is just the representation of real object that created by using softwares, the 3D model has to be detailed and precise just like the object, and with 3D model we can view and explore the object from various angles (top, bottom, front, back, left, right, etc.). A 3D model is close to real object than 2D. That's the main strength of 3D model compare to 2D [12][13].

Despite these differences, 3D computer graphics rely on many of the same algorithms as 2D computer vector graphics in the wire-frame model and 2D computer raster graphics in the final rendered display. In computer graphics software, the distinction between 2D and 3D is occasionally blurred; 2D applications may use 3D techniques to achieve effects such as lighting, and 3D may use 2D rendering techniques. [14][15].

In order that 3D model can move, the object need to be added by the element of animations. The function of animations are to move 3D model without making other model object on different angle. The animations function only have to rotate the object and giving details on that model object based on the angle rotation. Like hair, clothing, skin, grass, trees, and any other item that completes a scene. Scene is a series or collection of the frames, pictures, or model objects. The representation of 3D model without moving or not being animated is called frame. If the 3d model is moving or being animated is called a scene. The 3D animations are based on scene that has planned before. The short 3d animations video can consist of hundrerds of scenes, and the long 3d animations video (movie) can has thousand scenes and millions frames [16].

### B. Building 3D Model & Animations

In building 3D model, we have really understood the process of how artificial recharge wells were actually working. Because 3D model is the representation of real object, so the principle of artificial recharge wells were really have to exactly described by the 3D model. Not just the representation of the objects, the working mechanism of that artificial recharge wells also needed to be well drawn by the animations that moved the 3D model [17]. Because the function of this 3D model animations was also to introduce or explain about artificial recharge wells to scientists, students, goverments, industries, and society, so it needed to be well understood by the viewers even they never heard about artificial recharge wells before.

### C. Pre-Production Stage

Building the 3D model animations for artificial recharge wells more like the same with making movie of video (multimedia). The stages that used to build 3D model animations were pre-production, production, and post-production. Pre-production start with the basic and main concepts which were initially turned into a full story, the full story was outlined in the form of script as guidance in making the whole animations movie/video [18]. Form of the script was outlined in a table that represented the scenes, pictures, sounds, and timing. Because the 3D model animations of artificial recharge wells was part of the whole documentary science movie about artificial recharge wells itself, so the script that used in making 3D model animations was the script in making that movie.

After the script has revised and finished, the next step was outlining the script and story into story board. It was made up of drawings in the form of a comic strip, and was used to both help visualise the animation and to communicate ideas clearly. Story board was important to help animator visualise the 3D model including the movements, camera angles, details object, etc. [19]. The story board that used to visualise the 3D model of artificial recharge wells was drawn by images processing/editing software that was CorelDraw. The story board that had been drawn were showed by the folowing figures.

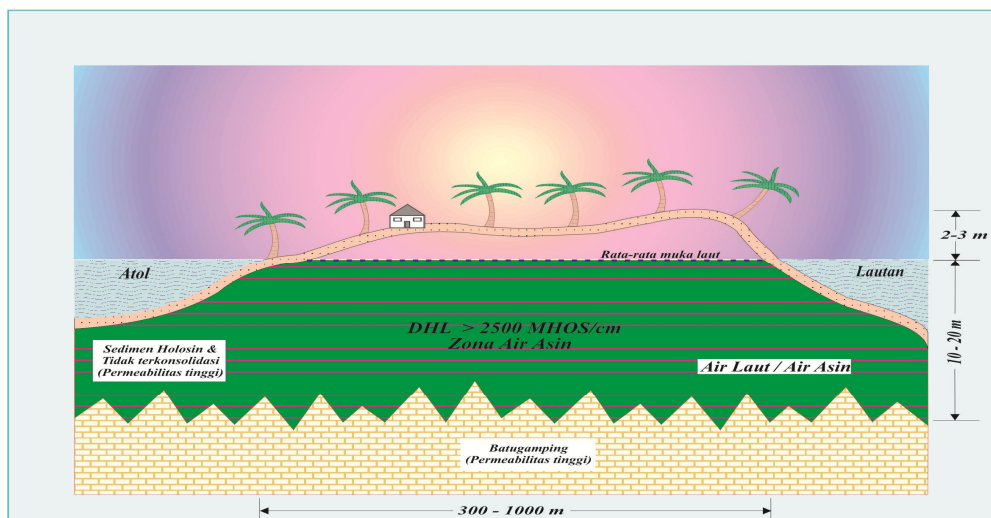


Fig. 7. Scheme of initial condition in small or very small island

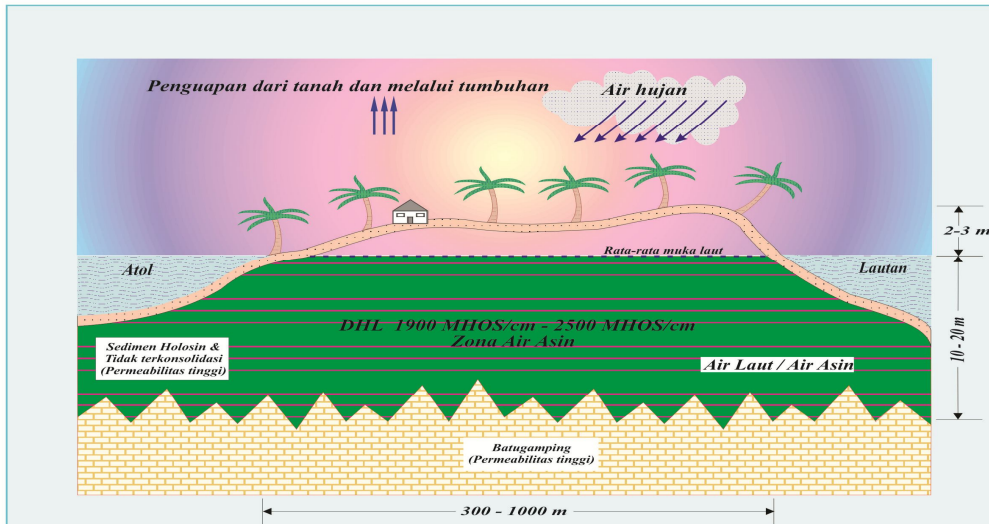


Fig. 8. Scheme of initial condition in small or small island when comes rain

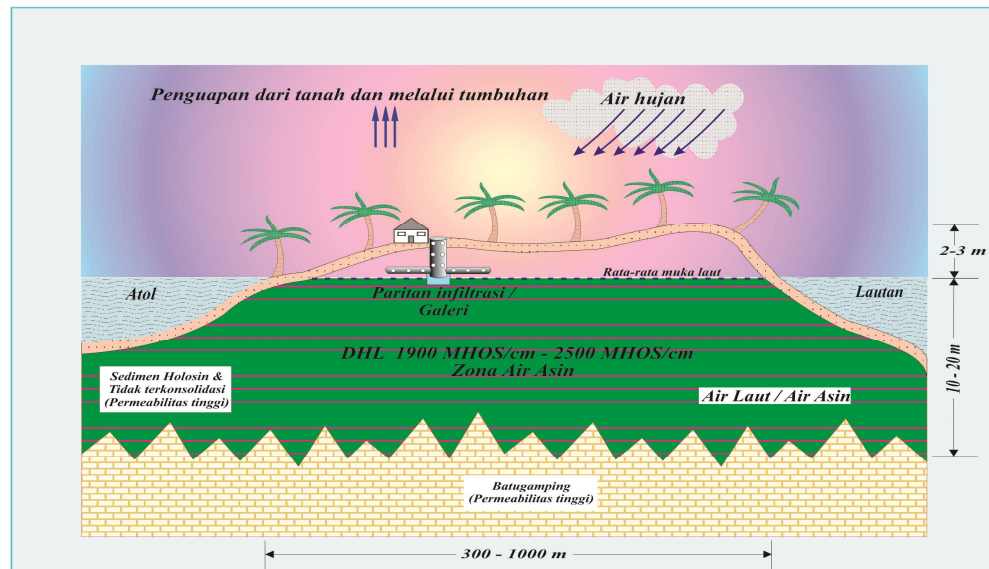


Fig. 9. Construction of artificial recharge wells is being developed

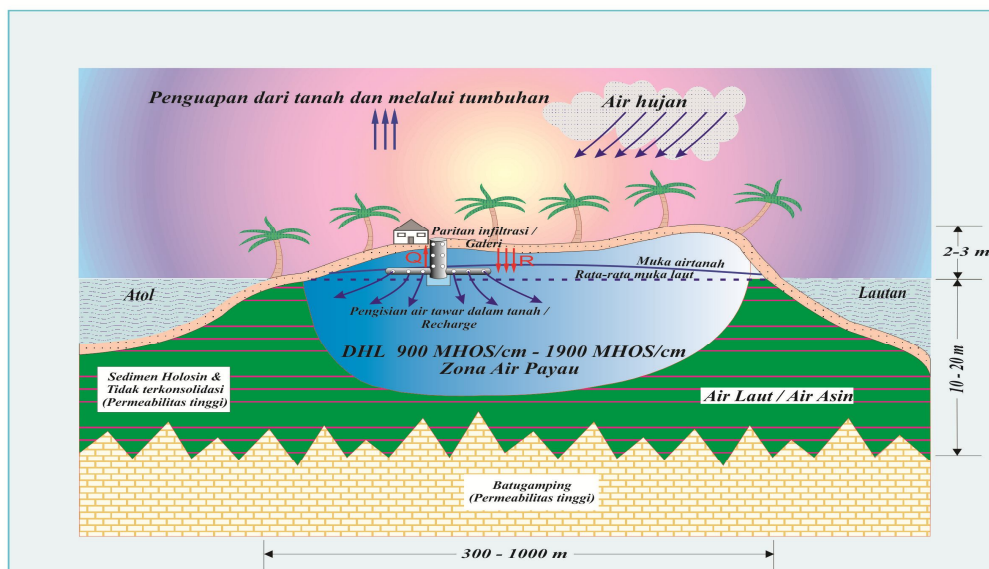


Fig. 10. The process of fresh water pushing the salt water

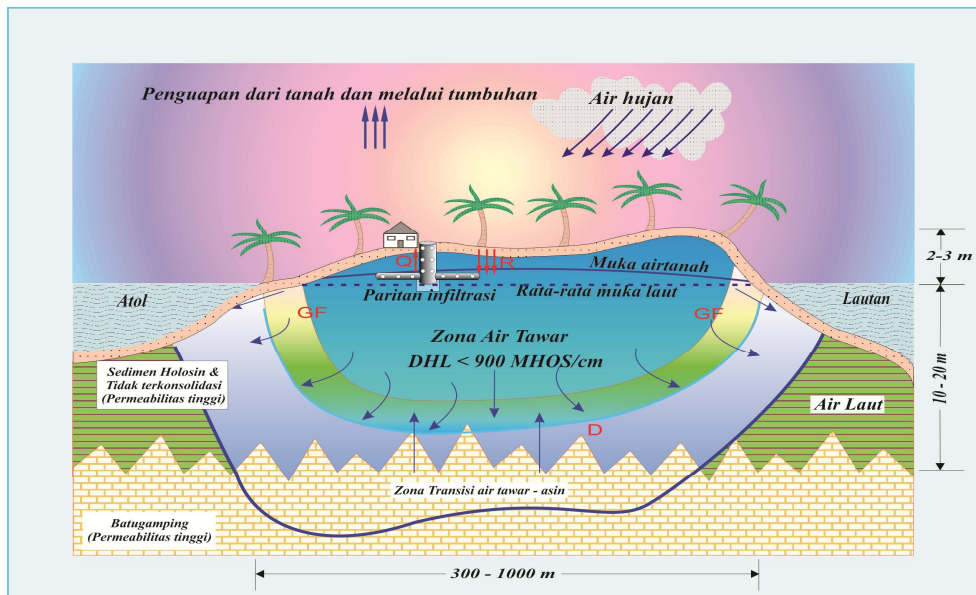


Fig. 11. Fresh water availability in small or very small island due to artificial recharge wells

#### D. Production Stage

The next process was layouting. Layouting means that to figure out the ambience or the background condition of the animations. Layout that used in this 3D model animations of artificial recharge wells was rainy condition, because the purpose was to show the works mechanism of artificial recharge wells, so the condition has to be how artificial recharge wells actually worked in rainy season to fill the galleries that will stream to the reservoir. The rainy condition background was described as cloudy and dark sky completed with drizzling. The process of creating layout was using 3Ds Max software. As described in figure below.



Fig. 12. The process of layouting in describing rainy condition

After the process of layouting the next process was modelling. Like have been discussed above, model in 3D animations was the representation of the the real object. So, modelling in 3D animations of artificial recharge wells was about how to make representation of artificial recharge wells include the galleries, reservoir/tank, soil/land, ground water, rain water, soil layer, and others. Because a lot of objects that need to be modelled, so there would be a lot of models to represent that real objects. The process of creating those models were using 3Ds Max software. That process is described by the figures below.

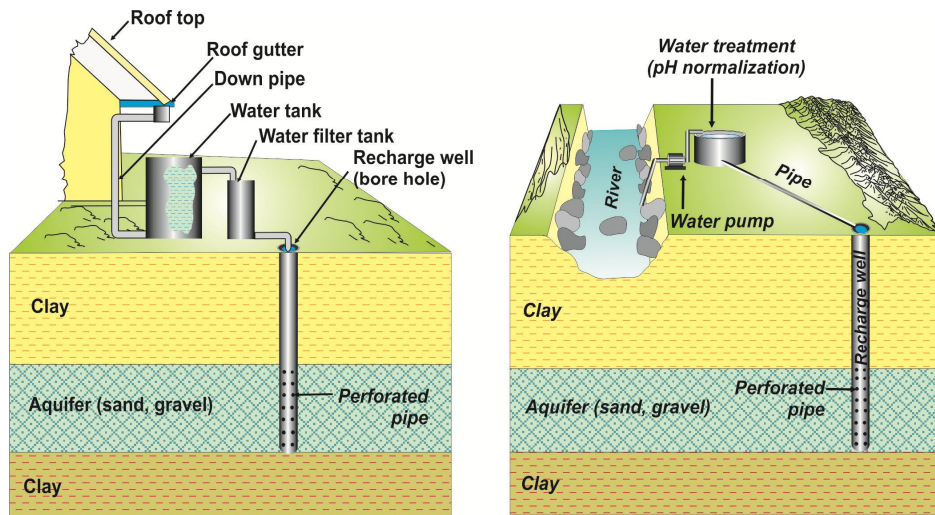


Fig. 13. Picture of gallery and tank before created into 3D models

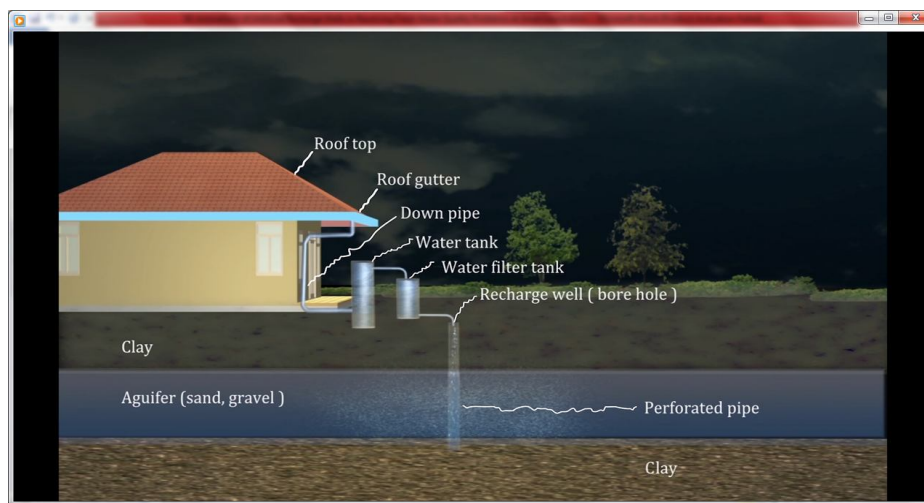


Fig. 14. After creating the 3D models of tank, gallery, pipe, and so on

In building 3D models, beside every model has to be exactly the same with the object especially for the process of how those artificial recharge wells worked. The model also can be rotate in any direction to view from the various angle. Like have been explained above this was the advantage of 3D than 2D. The purpose of this model rotation in order to give the flexibility of animators to show the work of artificial recharge wells from many angle. So, viewers can understand fully the benefit of those wells [20].

After each models have been built, the next step was texturing the models. Texturing means that giving the skin of every models. In did this, it means that the house, galleries, soil, water, tank/vessler, and others needed to be added the textures or skins. Texturing was really important in 3D model because texturing made 3D model felt alive. Because the purpose of 3D model was to create the representation of object in reality as real as possible, so texturing was mandatory in creating 3D model. In texturing the artificial recharge wells actually was difficult as texturing others 3D model especially like living forms (humans, animals, plants), because in making 3D models of everythings that involved in artificial recharge wells process there was no living things, they were the rain, house, galleries, tank/vessel, ground water, and else. The process of texturing those models were using 3Ds Max software.

The next process of building 3D model animations was lighting, lighting was very important because it can draw the feelings and attention of the viewers. If the process of lighting was unaproprate, it will mismatch with the 3D model and will cause wrong impression of 3D animations that being presented by the viewers. Because the wrong lightning technique will cause the good condition into the bad also with vise versa [21]. In this 3D model animations of artificial recharge wells, the lighting was set into dark condition because of rainy seasons, in order to draw the process of how filling the groundwater with rain water through the galleries and accomodated into tank/vessel. The lightning was described in figure 15. The process of making this lighting was by using Adobe After Effect software. In the last of production process the step was animations. It meant that the 3D models that have been built before were moved based on the story board or the script that has been made before making 3D models. In this 3D model animations that represent



artificial recharge wells, part of the animations were the drop of rain water the sky/cloud to the ground, and that rain water absorb into the soil and wells. Others 3D model like the house, galleries, tank/vessel, etc. were remain still or not moving. The point of animations in work mechanism of artificial recharge wells was the movement of water from the sky into below of the ground. The process making of animations artificial recharge wells were by using Adobe After Effect software, which is shown at below picture [22].

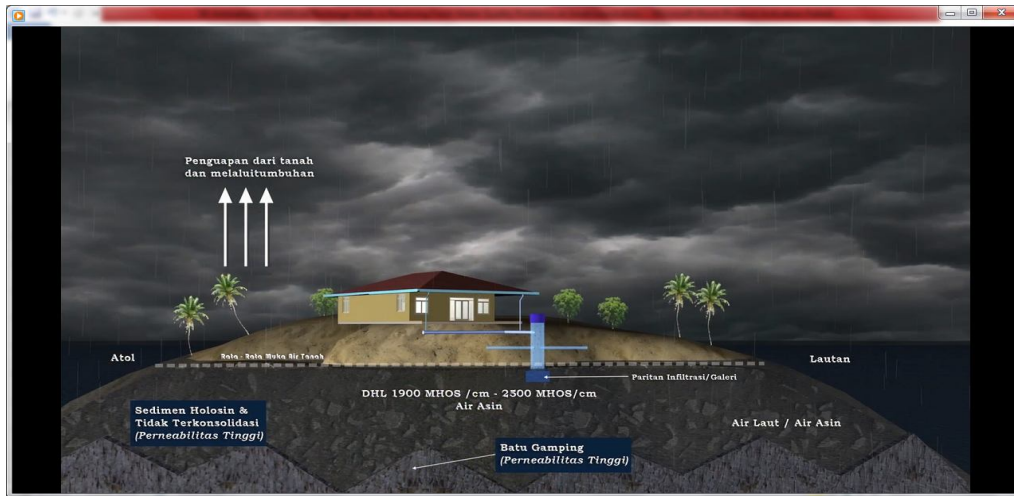


Fig. 15. The process when rain water drop into the ground

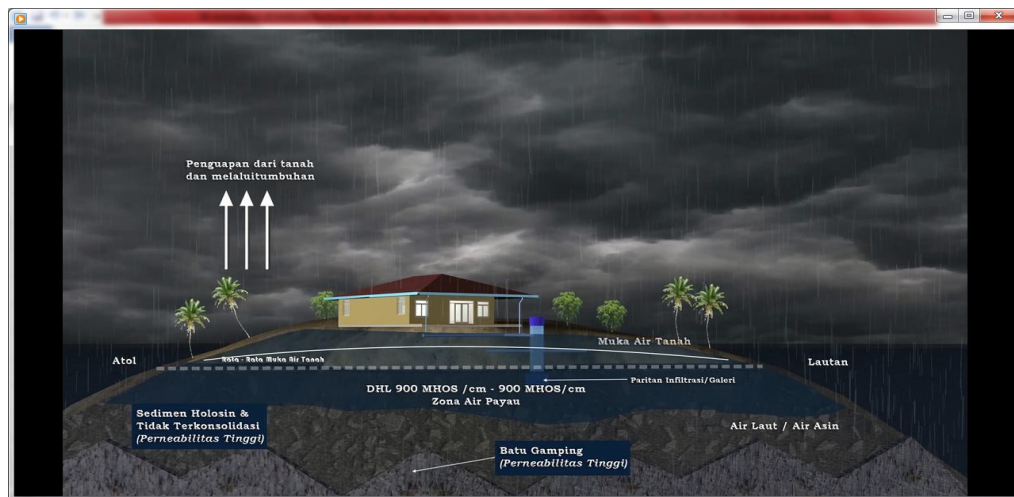


Fig. 16. Rain water start to fulfill the ground water

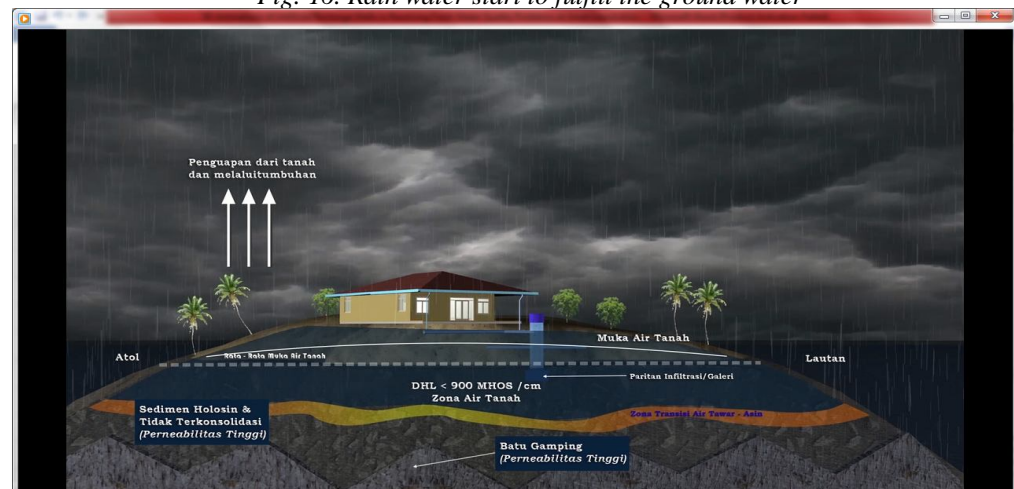


Fig. 17. Rain water start to push ground water deeper

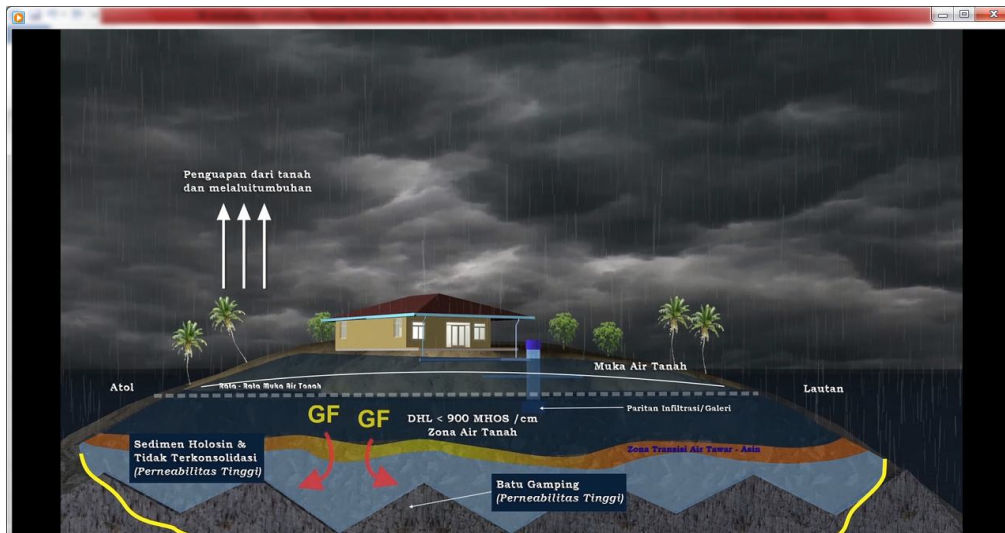


Fig. 18. The artificial recharge wells process the rain water in ground water to provide the fresh water in small or very small island

The difference of 3Ds Max and Adobe After Effect softwares was 3Ds Max to be used to create the models and details or features which attached to that models in representing objects in the real world [23]. Adobe After Effect was used to make the 3D models can move based on the effects that were added. The effect itself was the representation of algorithm or arithmetic models in order to move the objects [24]. So, the 3D model can't be said as animations if there was not supporting software to move the 3D model, also animations will be worthless if there wasn't the software to create the 3D model. Both of them were needed to create the 3D model animations of artificial recharge wells.

#### E. Post-Production Stage

This phase was started with compositing, where the job of compositing was to render the final 3D model animations to become a video or film. Render means 3D model animations can be seen a video and can be played with others devices or players. The 3D model animations which were created before in Production phase was the raw of the video or film, and can only played or watched in animators computer who made those. Render also means to fix of un-smooth the movement of 3D models, in order to viewers who saw this 3D model animations video in others players will not be disturbed by interrupted/noise video. The last thing the process of render means to fix the coloring video, this was important process because we wanted to make sure that the 3D model animations video has perfect color or lighting, to avoid the look that was too bright or too dark or unmatch/wrong color of the objects [25]. The process of compositing was using Adobe Premier.

The next process in this phase was sound editing, because the purpose of this 3D model animations of artificial recharge wells was to be included as part of documentary sciences about the wells itself, so the 3D model animations will have sound in accompanying the look of animations. The 3D model animations of artificial recharge wells was made to explain how the works of artificial recharge wells. The main sound in accompanying was the voices of researcher in explaining the mechanism of that wells, plus with the soft music behind the voices to bring the emotions of viewers. The 3D model animations was also enriched with the sound effect of rain condition (thunder, rain water drop, etc.), the same with music function this sound effect was added to bring the feelings or emotions of viewers. This little things like music and sound effect were very important to make the movie ambience or atmosphere can result more value to the video itself [26]. The process of sound editing was done with the support of Adobe Premier software.

The final process in post-production phase was video editing. As informed above this 3D model animations was a part of science documentary film/video which explained the planning, intallation, analyzing, and utilizing of artificial recharge wells in Pari island. This 3D model animations was attached to that video, by using Adobe Premier software. The function of video editing was to make sure in that documentary science film everythings were fine based on the initial script, including the stock shoot, narration, dubber voice, lightning, and also to combine between the 3D model animations and rest of the movie [27]. After video editing was finished, the next process was rendering the whole movie including the 3D model animations that have been attached. As explained above rendering was meant to play the movie in various devices or players, in this case the movie was transformed into DVD. As described above 3D Max software was used to create the 3D models. Adobe After Effect software was used to create the movements of 3D models. And Adobe Premier was used to edit the whole video into becoming the movie or film that can be watched in various devices/players [28].

#### IV. CONCLUSIONS

Indonesian archipelago is very big with more than 17.000 islands and most of the islands are categorized as small islands, also amongst them are very small islands or tiny islands with less than 100 km<sup>2</sup>. In small and very small islands have issues one of them is lack of fresh water availability, because of the sizes and structures of that islands made the sea water intrusions are easily to occur. In order to provide fresh water continuously even on summer season, researchers from Research Center for Geotechnology – Indonesian Institute of Sciences (LIPI) have initiative to solve this problem by building artificial recharge wells, which have function to accommodate the rain water on rainy season. With this method and technology it's possible to get the fresh water even during the summer season, because the sea water intrusion to the ground water will be normalized by artificial recharge wells that contain rain water.

Because the importance of the problem that going to be solve in providing fresh water to very small island's (Pari island) people. It was needed to make the 3D model animations of artificial recharge wells in order to explain the works mechanism of that wells, which will be useful for researchers to improve the process in optimising the work and result. The 3D model animations will be useful for further research to be implemented in others area/region which also have problem in fresh water availability and quality. The 3D model animations also as contribution of LIPI's researchers in trying to make real solutions to the society, by applying the sciences and technology which they mastered.

The 3D model animations was constructed through series of process and phases. The phases were: pre-production, production, and post-production. Each of those phases were followed by the process like building the scenario, the story board, layouting, modelling, lightning, animation, compositing, sound, and video editing. Those process using specific multimedia softwares, they were: 3Ds Max, Adobe After Effect, and Adobe Premier.

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