Assessment of Managed Aquifer Recharge Impact on Shallow Groundwater resources and Social Return on Investment: A Case Study of Nontree Sub-district, Prachinburi Province, Thailand

T.C. Pharmaceutical Industries co., ltd.

Groundwater Resource Institute
Khon Kaen University

Prommarach, Thanyaporn[1], Pholkern, Kewaree[1,2], Saraphirom, Phayom[1,3], Aksornklang, Rattaweep[1], Kreetep, Jiraporn[1], Homsin, Napon[1], Choenkwan, Sukanlaya [2], and Luepradit, Arunya [4]

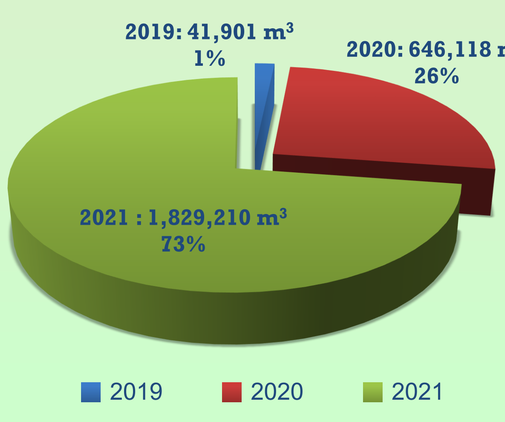
[1] Groundwater Resources Institute, Khon Kaen University, Khon Kaen 40002, Thailand, [2] Faculty of Agriculture, Khon Kaen University,Khon Kaen 40002, Thailand, [3] Faculty of Engineering, Khon Kaen University,Khon Kaen 40002, Thailand, [4] T.C. Pharmaceutical Industries Company Limited, Bang Bon, Bangkok 10150, Thailand

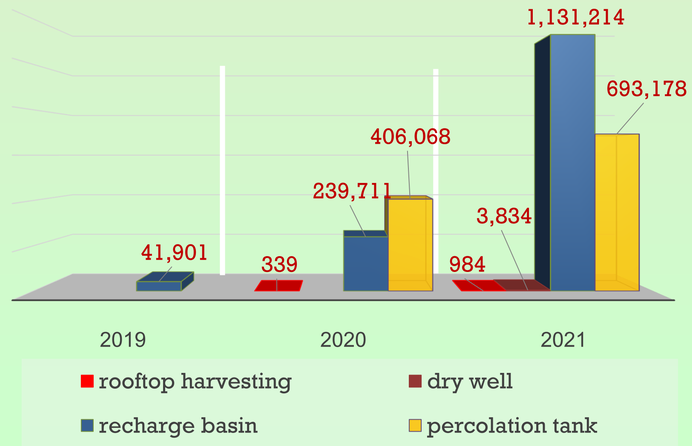
Corresponding Author: thanypr@kku.ac.th

Abstract

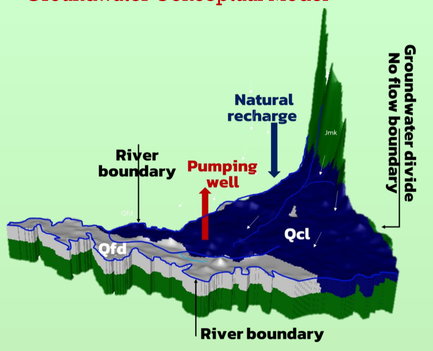
Nontree sub-district of Kabinburi district, Prachinburi Province was selected to be the Managed Aquifer Recharge (MAR) demonstration area due to this area has been facing floods, droughts, and a lack of water storage facility. The MAR systems have been constructed under the study of hydrogeological investigation, MAR suitability maps and detail designs the MAR systems. The 34 shallow MAR systems of 4 methods including recharge basin (23), percolation tank (4), dry well (2), and rooftop harvesting (5) were conducted from 2019-2021 for harvesting excess water in rainy season to store in shallow groundwater, to use for agriculture in dry season, and to balance the aquifer storage. There were monitoring systems installed to test and assess the impact of MAR on quantity and quality of groundwater. Nontree sub-district was classified into two major aquifers, first the fractured rock aquifer and second is unconsolidated rocks. The hydrogeologic of Nontree sub-district were classified consist of five units, namely Fluvial Deposits, Colluvium, Middle Khorat, Metasediments and Volcanic. The characterization of groundwater in this area divided to shallow and deep groundwater. The shallow groundwater consists of the sand and laterite of Colluvium Aquifer and the weathered stone of Middle Khorat Aquifer with the thickness about 10-20 m. While the deep groundwater consists of silt and sandstone deposited of Middle Khorat Aquifer. There are about 7.70 Mm^3 /yr are being used for domestic, agricultural and industrial purposes. Shallow groundwater usage is about 4.4 Mm^3 /yr, usually use for agriculture, which is the main land use of this area. The quality of both shallow and deep groundwater is fresh water. From 2019-2021, MAR systems recharged water to shallow aquifer for around 2.5 Mm^3 in Nontree sub-district. The impact of Managed Aquifer Recharge in the Nontree sub-district on groundwater level and mounding or spreading areas was assessed using numerical groundwater modeling, namely Visual MODFLOW. The simulation shows that the shallow groundwater level in this area was increased with rang 0-3.7 m (average 1.7 m.) and spreading area of recharged water is about 2,800 rais or 4.5 km^2 in 2021. Moreover, the socio-economic of MAR systems is also investigated using Social Return on Investment (SROI) method. An SROI analysis produces a narrative of how MAR systems create and destroy value in the course of making a change in the study area and a ratio that states how much social value is created for the amount of investment. The SROI of MAR systems in 2021 and the next 10 years (2031) are 2.2 and 16.81, respectively, which means the created value higher than the investment value by about 2.2 times and 16.81 times in 2021 and 2031, respectively.

From 2019-2021 MAR systems recharged water to aquifer for around 2,517,229 m^3



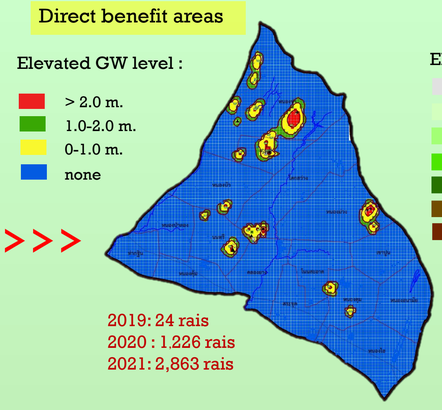


Groundwater Conceptual Model

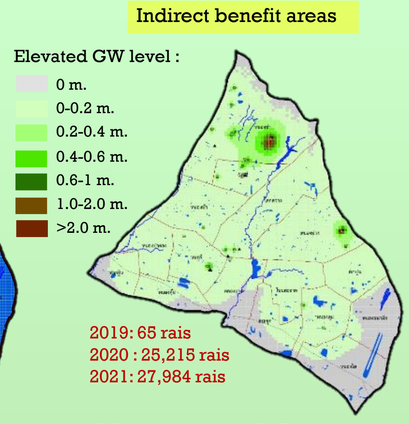


Estimated by groundwater modeling

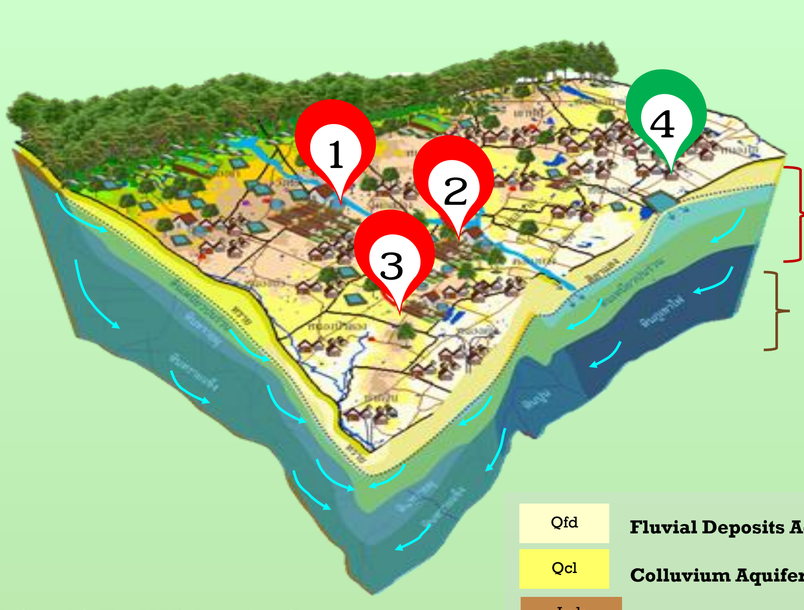
Direct benefit areas



Indirect benefit areas



The shallow groundwater level in this area was increased by around 1.7 m. and the spreading area of recharged water is about 4.5 km^2 in 2021.



1, 2, and 3: The MAR Learning Center.

4: The MAR community network coordination center.

Qfd	**Fluvial Deposits Aquifer (sand, clay)**
Qcl	**Colluvium Aquifer (sand, silty clay, laterite)**
Jmk weathered	**Middle Khorat Aquifer (Silt and sandstone Weathered)**
Jmk	**Middle Khorat Aquifer (Silt and sandstone)**
PCMs	**Metasediments Aquifer (limestone, slate)**
Vc	**Volcanic Aquifer (andesite, rhyolite)**

Achievement of MAR systems in Nontree sub-district

1. **There is an increasing variety of agricultural activities and increasingly high value.**

2. **Abandon agricultural lands have been changed to be fertile agricultural land.**

3. **Agricultural lands have been expanding.**
4. **Farmer incomes have been increased ranging from** 10,000 to 100,000 baht per year
5. **More water security for water supply agriculture in a village level.**

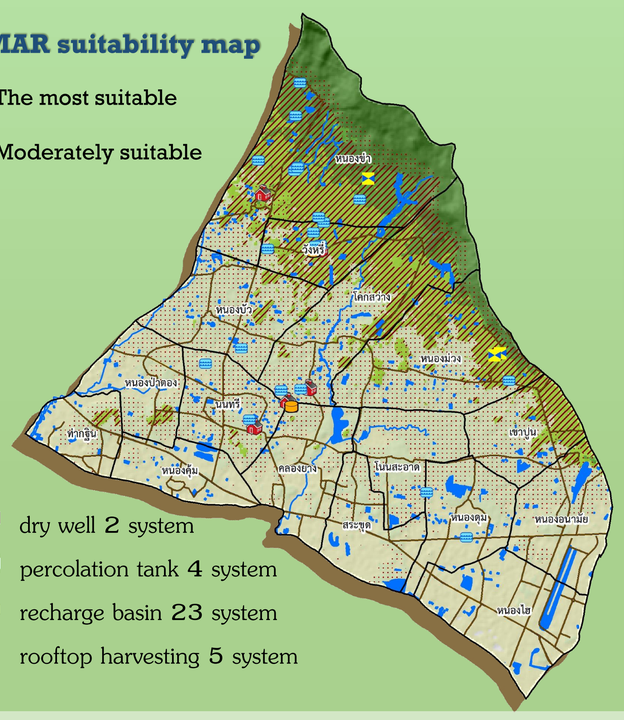
The MAR systems Map in Nontree sub-district (Since 2019-2021)

The 34 shallow MAR systems

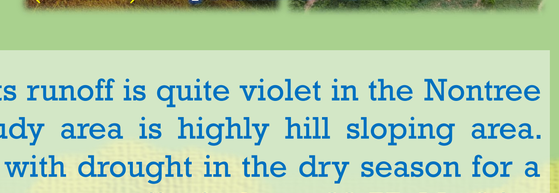
MAR suitability map

The most suitable

Moderately suitable



BEFORE **AFTER**



There is a lot of surface water resource and its runoff is quite violet in the Nontree sub-district it is due to the fact that the study area is highly hill sloping area. As a matter of fact, the area has been facing with drought in the dry season for a long time. In the rainy season, there is access runoff of about 22.77 Mm3/yr. flowing out of the area especially into the downstream, whereas in the summer season, the area is a shortage of water about 3.68 Mm3/yr. Therefore, if we can harvest this amount of access water to be used in the MAR process recharging to shallow aquifers by several techniques: well, recharge basin , roof harvestings and percolation tank. These operations will help local farmers to exploit the water for their agricultural products.

From calculating the social returns on investment (SROI) method in 2021 and 2031 are 2.2 and 16.81 respectively. Within a ten-year period (2021-2031) of MAR operation indicates that the system may be the most effective.