การบริหารจัดการ การเติมน้ำในระยะยาว

รศ.ดร.สุจริต คูณธนกุลวงศ์
คณะวิศวกรรมศาสตร์
จุฬาลงกรณ์มหาวิทยาลัย

20 ธันวาคม 62

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Household Scaled Rainwater Tank System

- Concept and Practices -

Sucharit Koontanakulvong[1] and Udorn Jaruratana[2]

Abstract: Water Supply in rural area is still a crucial issue in many countries. Storage in groundwater aquifer is a promising alternative for water harvesting. Rainwater tank system on a household scale is proposed for storing excessive water both in the tank and in the aquifer during rainy season and recovering the recharged water from the aquifer for use during dry season. The design concept is described with a calculation sample for reference. From the data of water level and water quality, obtained through monitoring 400 constructed tank systems, the system proposed is proved to be workable and effective in both quantitative and qualitative aspects, especially in the area with high rainfall and moderately or low yielded aquifer.

1 Introduction

Water demand has always increased due to economical and social development, while water supply development especially from surface water is limited due to topographical constraints and environmental awareness. The groundwater then becomes critical source for many areas, especially in rural areas. This caused the decrease in groundwater table in many major aquifers, including those in Bangkok and its vicinity, that need proper management to balance natural conditions (Somchai, 1999).

Water supply in the rural area is still crucial for rural development, and therefore many water harvesting methods had been studied and proposed, e.g., tameike (irrigation tank) method (Minami *et al.*, 1986) and qanat (Pouraghniaei, 2000). At the same time, groundwater artificial recharge is becoming an important issue to help balance the groundwater table decline and many studies also had been done to find its technical and economical feasibility (Nippitawasin, 1989; Pyne, 1994; Kelvin, 1998; Sucharit, 1999).

This paper proposes the concept of rainwater tank system to be used as micro water supply and groundcrease in groundwater use, groundwater table also declines and make conditions more suffered.

Furthermore, people in the area with less yielded aquifer suffer more. Thai government, with the policy of clean water supply for rural area, had promoted and helped constructing the small scaled rainwater tank with the capacity of 6-12m^3 for each household in order to store excessive rainwater during the rainy season and to be used during dry season. This policy helps lessen the water shortage problems in the dry season, but the groundwater is still in need though its use is confined in the shorter period.

The concept of rainwater tank is then modified to function not only as rainwater storage but also as groundwater artificial gravity storage and recovery device by constructing one more slow sand filtration tank so that excessive rainwater from the roof during rainy season, which is overflowed from the storage tank, is filtered, recharged into and stored in the aquifer through a working well (Nippitawasin, 1989; PWD, 1998). This stored rainwater can then be recovered for use by pumping up from a recharge well again during dry season after rainwater stored in the

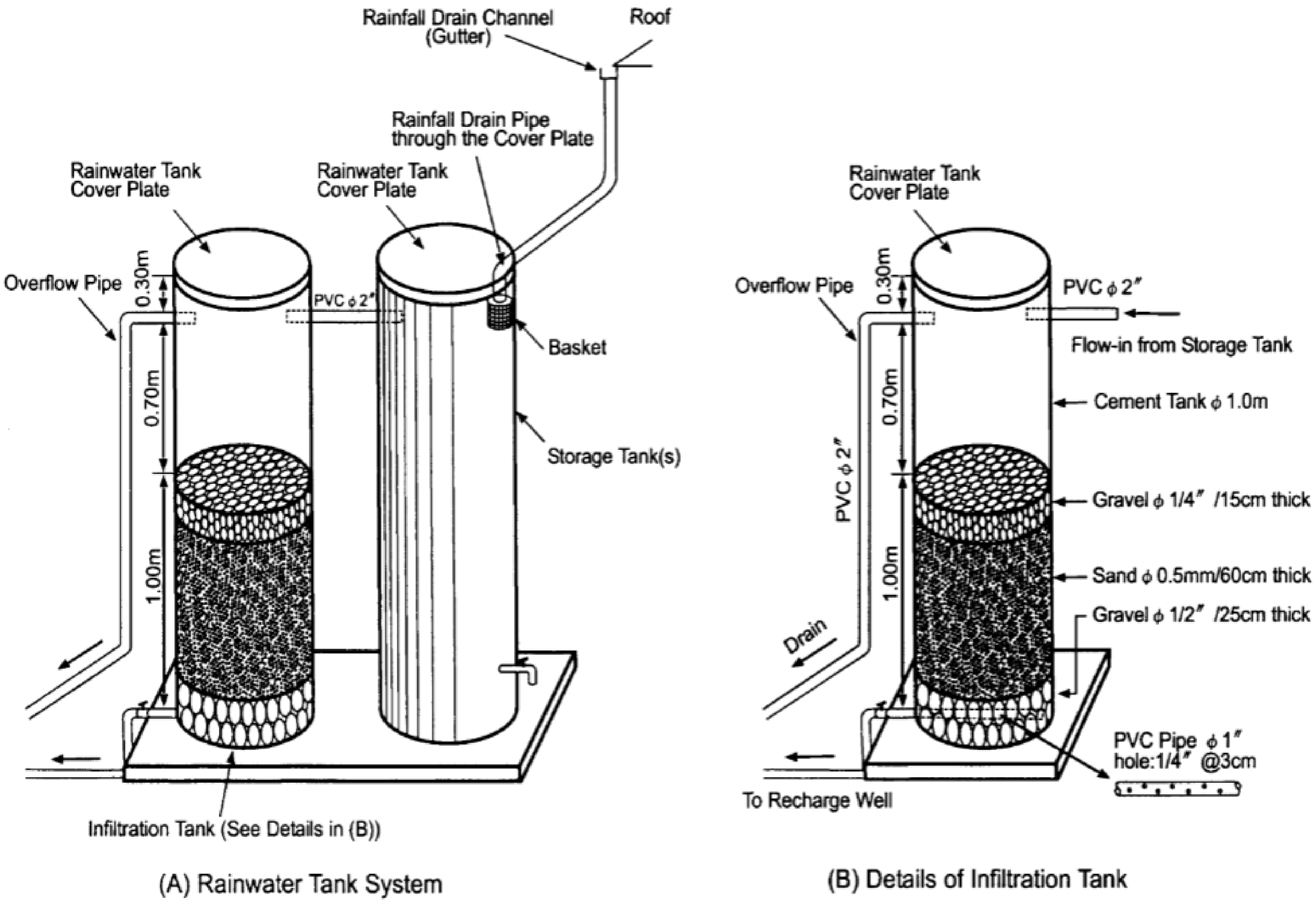

Figure 1: Schematic sketch of rainwater tank system

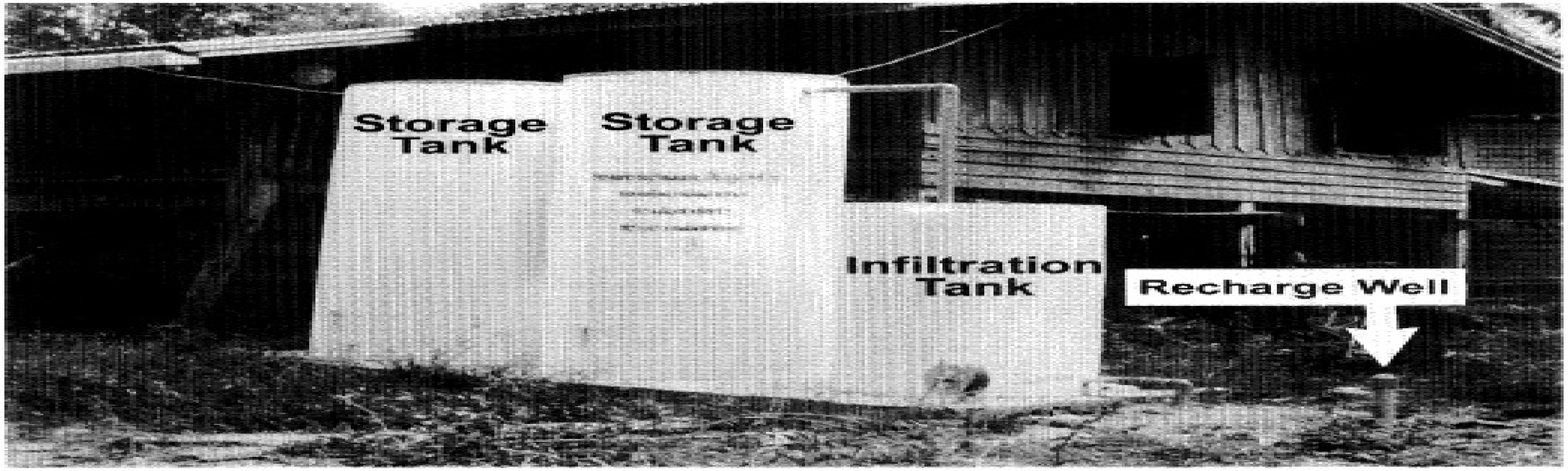

Photo 1: Rainwater tank system in practice

Table 2: Water quality analysis results

Parameter	Standard	1st (Sep.29, 1997)		2nd (Oct.2, 1997)	
		Raw Water	Filtered Water	Raw Water	Filtered Water
1.pH	6.5-8.5	7.85	7.66	7.73	7.60
2.Turbidity(NTU)	≤ 20	45.1	2.75	92.8	24.8
3.Color(units)	≤ 15	30	5	40	30
4.Iron(total)(mg/ℓ)	≤ 1.0	0.5	0.03	0.85	0.34
5.Hardness(mg/ℓ)	≤ 300	73	69.8	69	67
6.TDS(mg/ℓ)	≤ 1500	114	98	160	137
7.Total Coliform (MPN/100mg)	< 2.2	3300	330	2800	20
8.Faecal Coliform(MPN/100mg)	no	<18	<1.8	<18	<1.8

Table 3: Water quality analysis results (poisonous aspect, Sept. 1997)

Parameter	Standard Max.		Measured Value	
	Raw Water	Pipe Water	Raw Water	Filtered Water
1.Dieldrin (μg/ℓ)	0.1	0.03	0.002	0.002
2.Aldrin (μg/ℓ)	0.1	-	0.004	0.001
3.Heptachlor (μg/ℓ)	0.2	0.1	0.002	0.001
4.Heptachlor Expoxide (μg/ℓ)	-	-	0.002	0.002
5.Lindane (μg/ℓ)	-	3	0.002	0.002
6.HCB (μg/ℓ)	-	0.01	0.002	0.002
7.o,p-DDT (μg/ℓ)	1	1	0.002	0.002
8.p,p-DDT (μg/ℓ)	-	-	0.002	0.002
9.Methoxychlor (μg/ℓ)	-	30	0.002	0.002
10.Chlordane (μg/ℓ)	-	0.03	0.004	0.003

Ground Water Recharge Using Waters of Impaired Quality

Committee on Ground Water Recharge
Water Science and Technology Board
Commission on Geosciences, Environment, and Resources

National Academy Press
Washington, D.C. 1994

Groundwater Recharge Study and Simulation - Kamphaeng Phet Case Study -

Sucharit Koontanakulvong[1] and Chokchai Suthidhummajit[2]

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[2] Chula Unisearch, Chulalongkorn University, Banthatthong, Patumwan, Bangkok, Thailand 10330.

ABSTRACT. The feasibility of groundwater recharge scheme had been proposed to study in Kamphaeng Phet Province, about 400 km. north of Bangkok. The general movement of groundwater in the province was analysed and simulated from the data of the watertable monitoring program. Field experiment on artificial basin recharge was conducted and proved to be effective though sediment clogging issue was left to be solved. Water balance study from simulation results during the year 1997-2002 revealed that agricultural water use is the main reason for the decrease in groundwater table with the rate of 1-2 meters annually. To mitigate the situation, pumping control and/or groundwater recharge schemes are simulated and proposed in order to maintain the groundwater table as in the year 1997.

KEY WORDS. groundwater, simulation, water balance, recharge

INTRODUCTION

Water demand in domestic, industrial and agricultural uses gradually increases with the development of socio-ecomonics. This caused the decrease in groundwater table in many area in Thailand [1] and made people in rural area, who mainly rely on shallow well, suffer from water shortage especially during dry season [2].

Groundwater recharge scheme had been proposed to study in Kamphaeng Phet Province in order to mitigate the water shortage problem in the long term. Groundwater table monitoring program was executed during the year 1995 to 1997 and the data were collected and used to understand and simulate the general conditions of groundwater in the Province. Field experiment on gravity recharge was also conducted to investigate the recharge effectiveness and efficiency.

This paper summarized the study results of groundwater movement in the Province and the water balance analysis during the year 1997 to 2002. The effects of pumping control and groundwater recharge schemes were studied by computer simulation, using the data from field experimental recharge basin, to find suitable means to maintain groundwater table as in the year 1997.

GROUNDWATER MOVEMENT IN THE PROVINCE

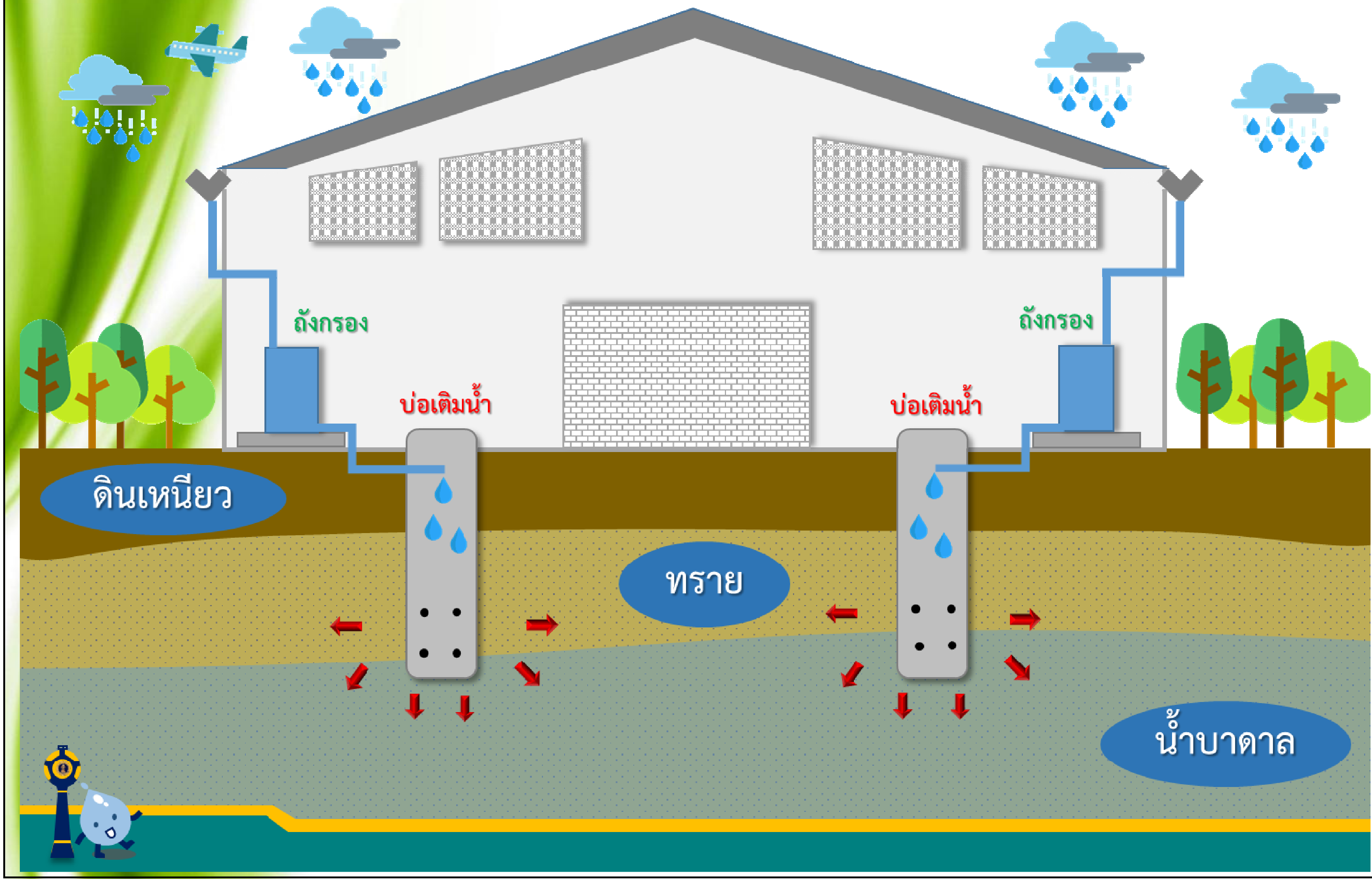
Kampheng Phet Province is located in the northern part of Central region of Thailand with the distance of about 374 km from Bangkok. The total area of the Province is 8,623 sq. km with the average annual rainfall of about 1,300 mm and the anuual evaporation rate of about 1,460 mm. Topographically, the western part is a mountainous area with small hills in the Northwest. The basin slope decreases towards the East with an alluvial floodplain near the Ping River starting from the central part of the Province.
Geologically, rocks in Precambrain Era could be found in the mountainous and hilly areas in the West and Northwest, where Quaternary deposits (both terrace and alluvium) are found to be laid

K. Sato et al. (eds.), *Groundwater Updates*

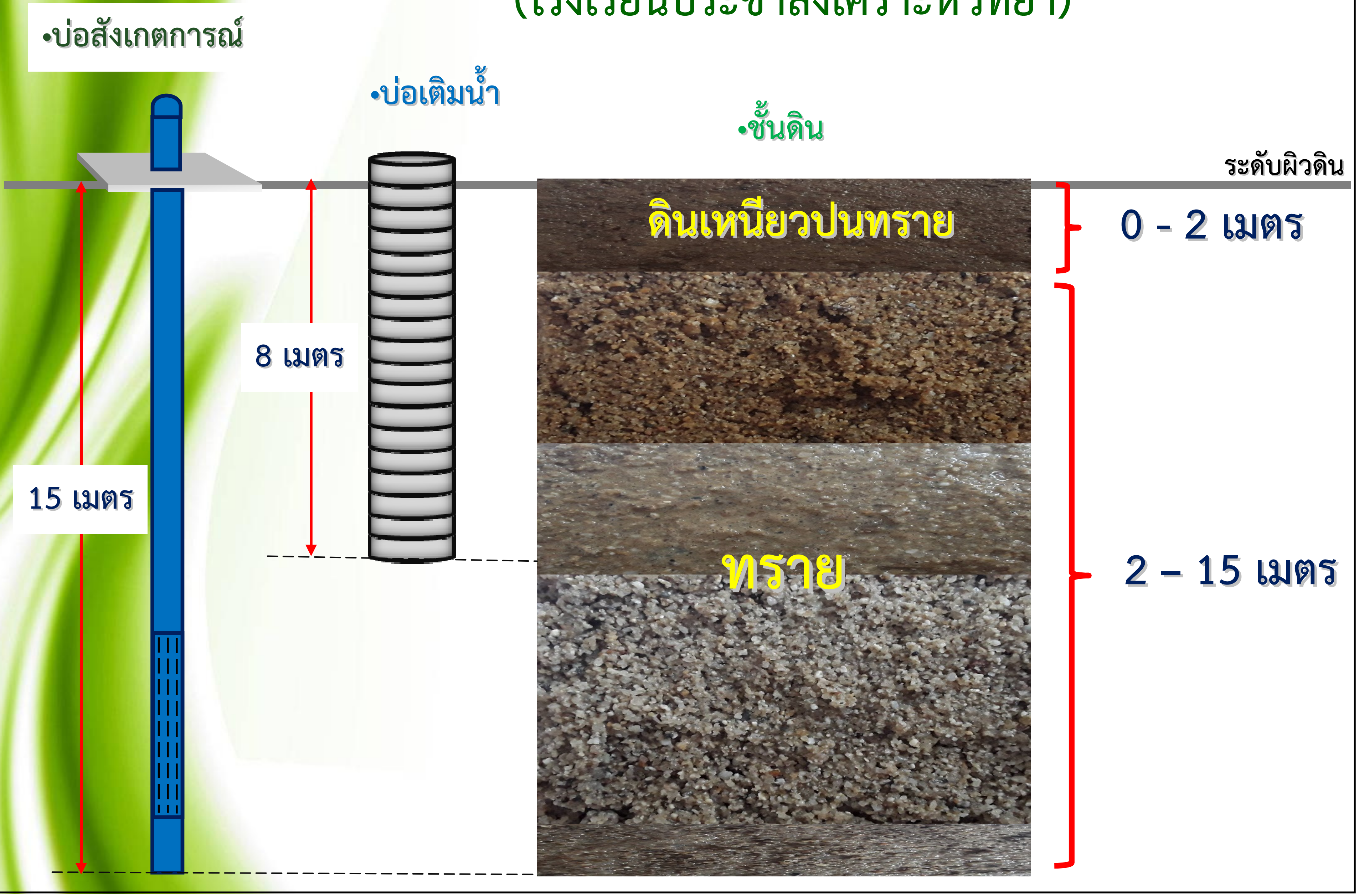
ระบบเติมน้ำฝนจากหลังคาลงใต้ดิน

โครงการ CSR “เติมน้ำให้แผ่นดิน เพิ่มน้ำใต้ดินที่บางระกำ”

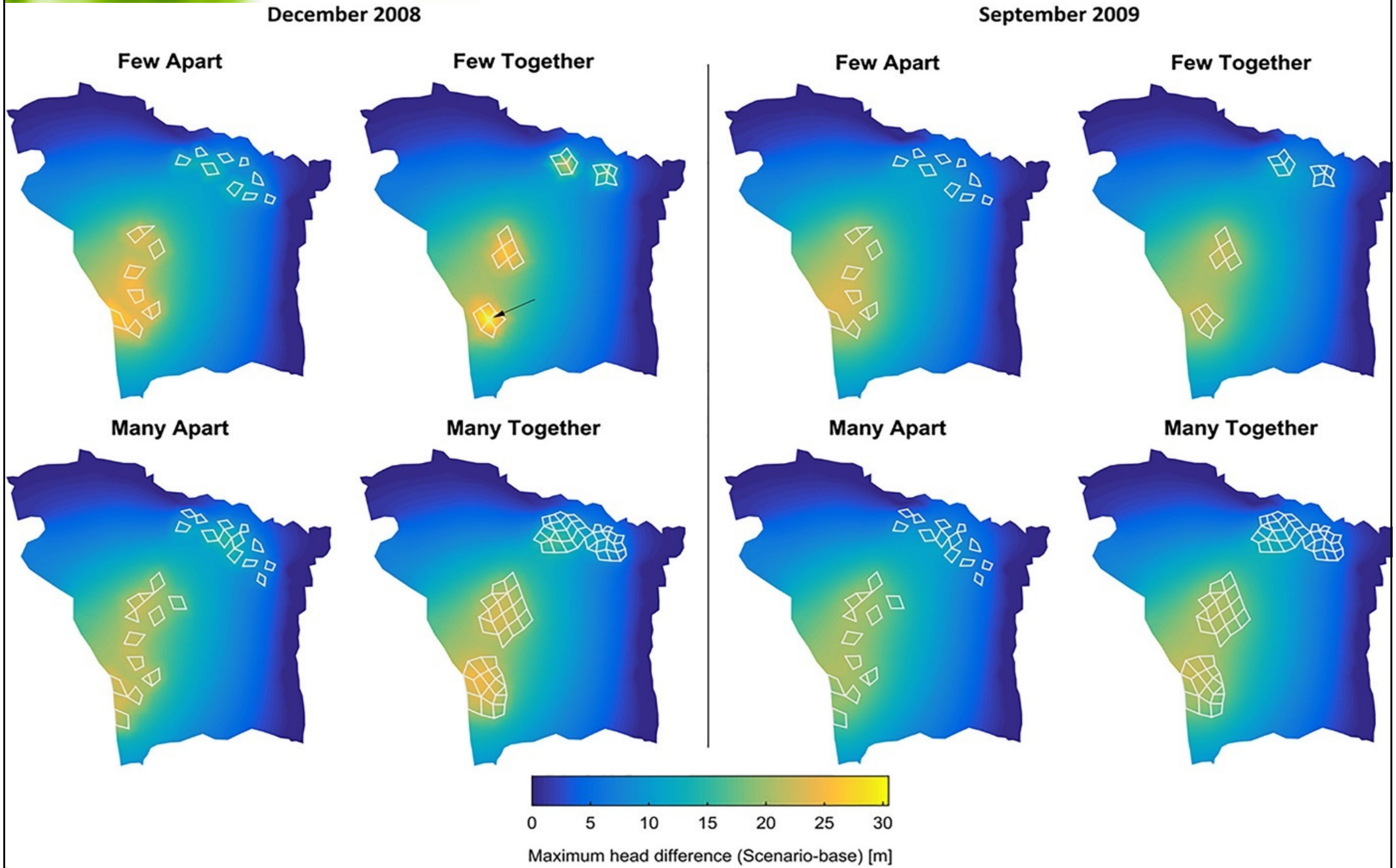
โรงเรียนประชาสงเคราะห์วิทยา อำเภอบางระกำ จังหวัดพิษณุโลก



ข้อมูลชั้นดินพื้นที่ก่อสร้างระบบเติมน้ำ
(โรงเรียนประชาสงเคราะห์วิทยา)



Increasing Groundwater Availability and Seasonal Base Flow Through Agricultural Managed Aquifer Recharge in an Irrigated Basin



Water Resources Research, Volume: 55, Issue: 9, Pages: 7464-7492, First published: 19 August 2019, DOI: (10.1029/2018WR024019)

สมดุลน้ำใต้ดินแม่น้ำยม-น่าน บริเวณพิษณุโลก

สมดุลน้ำในปีน้ำแบบต่างๆ ของแม่น้ำยมและน่าน ช่วงพิษณุโลก (หน่วย ล้านลบมต่อวัน)

ปีน้ำ	แล้งจัด	แล้ง	ปรกติ	น้ำมาก	ค่าเฉลี่ย
การซึมผ่านดิน	0.20	0.22	0.22	0.30	0.24
จาก แม่น้ำ	4.37	4.62	4.83	5.35	4.79
ออก แม่น้ำ	3.01	2.46	2.66	2.95	2.77
สูบน้ำออก	8.92	7.03	7.10	6.48	7.38

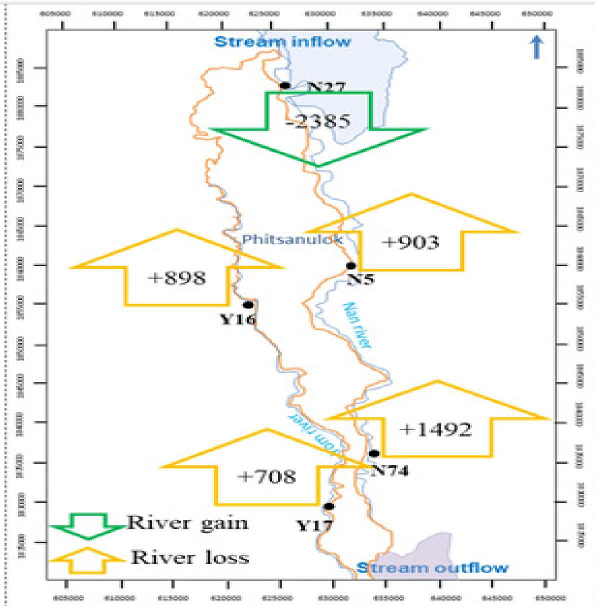


Figure 5.30 River stations and the conditions of river gain and loss

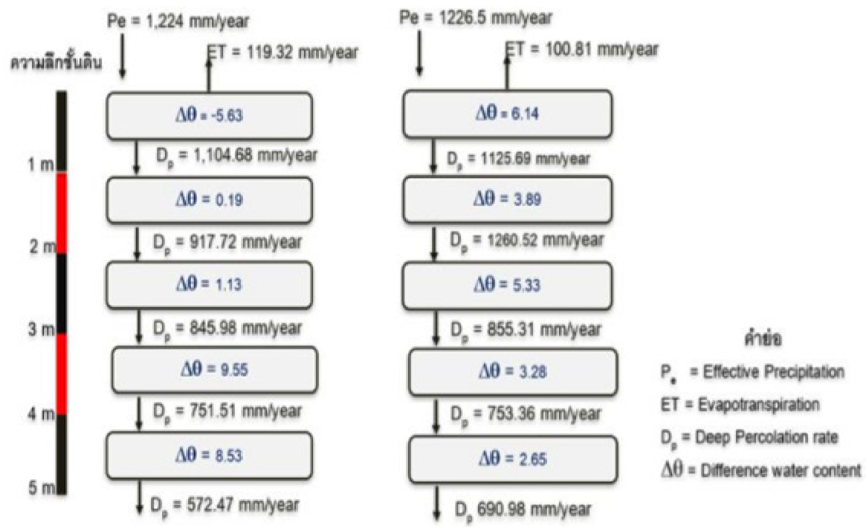
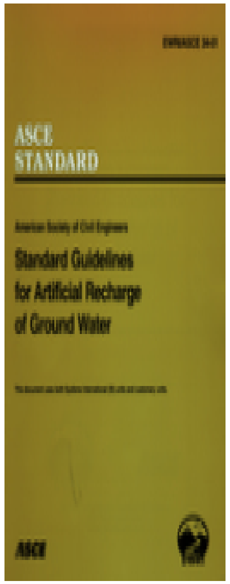


Fig. 8. Water balance and water content change in 2017-2018

มาตรฐานที่ใช้

- สหรัฐอเมริกา (ASCE)
- อินเดีย
- ISO 13973, 2014
- TIS/DGR xxxx



Standard Guidelines for Artificial Recharge of Ground Water

ASCE

EWRI/ASCE 34-01 | ISBN (print): 978-0-7844-0548-2 | ISBN (PDF): 978-0-7844-7078-7

CENTRAL GROUND WATER BOARD
MINISTRY OF WATER RESOURCES

GUIDE ON ARTIFICIAL RECHARGE TO GROUND WATER

NEW DELHI
MAY, 2000

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ISO/TR 13973:2014(en) Artificial recharge to groundwater

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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The committee responsible for this document is ISO/TC 113, *Ground water*.

Applicability of the Darcian Method for Recharge Estimation

Kim Perkins (kperkins@usgs.gov) John Nimmo (jrnimmo@usgs.gov) Unsaturated Zone Flow Project Home Page

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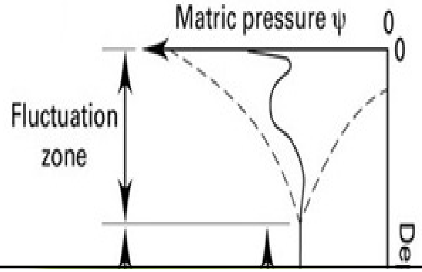
The Darcian method applied to steady flow conditions in the unsaturated zone (Nimmo and others, 1994) can produce high-quality local recharge estimates at diverse locations to provide a standard of comparison, for example between humid regions where streamgaging data are useful for recharge estimation and drier regions where they are not. This method is based on knowledge of the unsaturated hydraulic conductivity (K) at a point (usually deep) in the unsaturated zone where flow is downward and steady.

If flow under field conditions is steady and driven by gravity alone, then, according to Darcy's Law, downward percolation rate will be numerically equal to the hydraulic conductivity of the material at the measured in-situ water content. The Darcian unit-gradient method (Sammis and others, 1980, Nimmo and others, 1994) was originally used to estimate long-term average recharge rates in arid regions with thick unsaturated zones where, below some depth, flow is considered to be steady and driven by gravity alone. In shallower unstaurated zones in some environments, some form of this method may be applicable if changes in water content are slight and recharge rates may vary little over the course of the year or may exhibit a seasonal, repetitive pattern of variability. The Darcian method does not necessarily indicate total recharge as it only accounts for diffuse, matrix flow. Recharge due to preferential flow is inherently non-Darcian and, if significant, must be determined separately.



In the unsaturated zone, Darcy's Law may be represented in head units by the equation:

$$q = -K(q)\ [dy/dz+1]$$

where q = flow rate [LT^{-1}], K = hydraulic conductivity [LT^{-1}], q = volumetric water content [dimensionless], dy/dz = matric potential gradient [dimensionless], and dz/dz = 1 = gravitational potential gradient [dimensionless]. Under the unit-gradient

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Standard Guidelines for Artificial Recharge of Ground Water

This document uses both Système International (SI) units and customary units.

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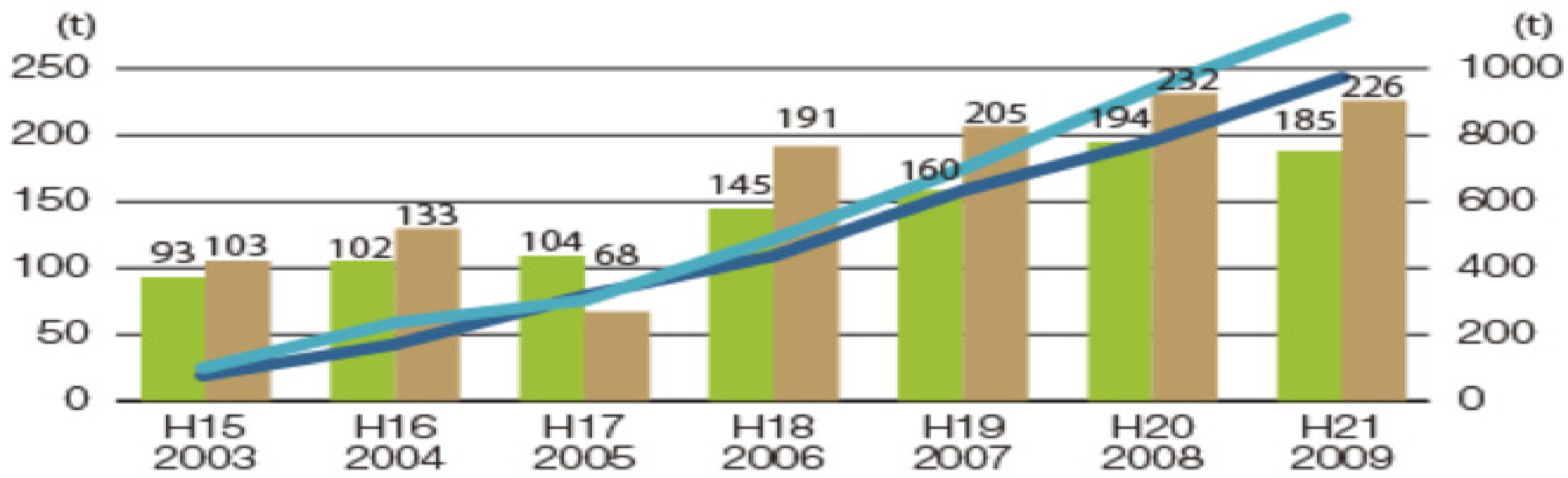
ตย. การเก็บค่าน้ำจากการเติมน้ำ

Water consumed vs groundwater recharged



※平成 17(2005)干ばつにより涵養量減　Drought in 2005

水使用量　water consumed (t)
地下水涵養量　groundwater recharged (t)
水使用量 (累計)　accumulated amount of water used (t)
地下水涵養量 (累計)　accumulated amount of groundwater recharged (t)

出典：ソニーセミコンダクタ九州株式会社提供資料より作成
Source : compiled from Sony Semiconductor Kyushu Corporation data

Payments for ecosystem services (1)

Days of off-season flooding	Payment to partner producers
30days	11,000Yen／1000m^2
60days	16,500Yen／1000m^2
90days	22,000Yen／1000m^2

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- ภายใต้เป้าหมายการลดความเสี่ยงจากภัยแล้ง เพิ่มความมั่นคง เพิ่มผลิตภาพและยุทธศาสตร์ภายใต้การเติบโตอย่างเป็นมิตรต่อสิ่งแวดล้อม (และยั่งยืน)

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