The importance of Helminth Eggs assessment in Indonesia for water reuse and disease prevention

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Abstract. Water as vital needs to our life must be fulfilled. Increasing population tends to water scarcity causes by the high demand and limited source. Water reuse is one of the solutions to face the challenge. Helminth eggs is one of the parameters for water reuse recommended by WHO. Previous studies have shown that there are helminth eggs presence in irrigation water and wastewater system in Indonesia, thus the possibility of disease by helminth eggs presence. This study was conducted to give an advice about the importance of helminth eggs assessment in Indonesia for better water reuse and prevent disease like soil-transmitted helminthiases. To detect the presence of helminth eggs in water, adaptations from several existing methods is required. Indonesia needs an exact method to determine the presence of helminth eggs. Government, institutions, and society have to collaborate to prevent the existence of helminth eggs for the water reuse purpose in the future. This can lead to increase quality of health and environment aspects.

1. Introduction
Water is an important element in life for every creature in the earth. Indonesia as the largest archipelago country in the earth has rich water resource for their people. Water resource in Indonesia consist of rainfall, river system, and groundwater with the total water availability around 690 billion cubic meters per year [1]. Unfortunately, this does not guarantee the fulfillment of clean water needs for the entire community. Water resource that can be used is clean water that meets quality standards to fulfill daily needs such as cooking, bathing, and washing. The decreasing quality of water in Indonesia becomes the major problem that needs to be solved. Natural disasters which were water and environmentally related such as water pollution, floods, droughts, landslides and forest fires causes environmental degradation. Nowadays, population increase and rapid industrial development also make a big alteration to land use and water demands that cause uncertainties in water resources availability [2].

Increasing water demand consequently will pressure on water resources. Many countries enduring water scarcity, where demand for water by all sectors cannot be fulfilled due to the impact of water supply and water quality. Water scarcity has become a major constraint to socio-economic development which affect our life [3]. To overcome the possibility of water scarcity, existing clean water utilization must be rapid and efficient. Water reuse is one of the solutions to avoid water scarcity. However, other problems that arise in conducting water reuse in developing countries are the limitations of technology that can be used and the absence of relevant regulations.
Water reuse quality standard that is potential to become a benchmark for the Indonesian state is EPA or WHO guidelines for water reuse. One of the microorganism parameters that must be removed from the water is helminth eggs, apart from bacteria, protozoa, and viruses. Helminth eggs are resistant to environmental stresses to cause an infection in reclaimed water [4]. The high prevalence of helminth eggs in Indonesia cause problem for human health such as helminthiasis [5]. Water reuse resource with abundant quantity in agraris country with high population growth is irrigation water and wastewater. Previous studies have shown that the presence of helminth eggs in irrigation water and waste water in Indonesia. This certainly increase insecurity to water reuse practice cause unfulfilled water quality standards. This study was carried out to show the importance of helminth eggs assessment in potential water resource for water reuse and to avoid any disease from helminth. This study is also expected to assisting in determine the appropriate water reuse technology in Indonesia.

2. Research methodology
Helminth eggs examination in Indonesia is usually used in the medical field. Therefore, methods for checking the presence of helminth eggs in the environment are still diverse. Various studies were conducted to determine the most effective and efficient method in accordance with the conditions of existing facilities and infrastructure. Helminth eggs examination in environment, especially in water resource for water reuse is really important things to be implemented. Irrigation water and wastewater is one of major source for water reuse.

To determine helminth eggs presence in irrigation water, preparation step is conducted before analysis. After removing all the floating dirt in the overnight settled sample, the resulting precipitate will be prepared for analysis [6]. Quantitative measure and analysis of helminth eggs was done by Bailinger method with some modification based on existing laboratories condition using Mc Master slide [7,8]. The modified Bailinger method can also be used to analyze the helminth egg presence in wastewater and sludge sample, albeit with completely different preparation step. Method used for enumeration of parasitic helminth eggs in wastewater relies on a sedimentation-floatation procedure developed by WHO. 5 L sample collected were settled for 8 hours or overnight. The supernatant then carefully discarded without disturbing the sediment using pump. Sediment settled was transferred into centrifuge tubes then was centrifuged at 1000 g for 15 minutes. The supernatant is removed and discarded. All the sediment transferred into one tube, use detergent solution of 0.1% Tween80 to rinse the centrifuge tube in order to ensure no sediment was left. Re-centrifugation then done at 1000 g for 15 minutes. After remove the supernatant, an equal volume as pellet suspended of acetoacetic buffer (pH 4.5) was added. Ether then added at a volume equal to twice that of the buffer and the mixture is stirred for 10 minutes. Samples was centrifuged at 1000 g for 15 minutes to separate mixture into three distinct phases: non fatty, heavier debris including helminth eggs in the bottom layer; buffer, clear phase; and thick dark plug at the top as the fatty material moves into the ether. Supernatant was discarded and the pellet was re-suspended in five volumes of saturated ZnSO4 solution, 33% with relative density of 1.18 [9].

The high frequency of flood in Indonesia make the examination of sludge in irrigation water and wastewater is also very important. The possibility of the resumption of sludge that has settled mixed with water allows for re-contamination. USEPA method can be used as preparation step [5]. For the future research, helminth eggs assessment method must be standardized based on existing condition of the country. This effort will be major help for better water reuse and disease prevention, especially helminthiasis.

3. Results and discussion
Developed country has facing difficulties in their means for better sanitation and health, Indonesia is not an exception. Hydrological regime and environmental quality changes according to the population growth. This situation turned out to be an outbreak of diseases related to water and climate [2]. One of the major impacts of increased population is reducing availability of water resources. Abundant water resources are not a solution to prevent water resources crisis. Smart choice to choose the right and
efficient solution and technology is needed [2]. The major difficulties in Indonesia is the human resources and technical issues.

High population makes the system function really hard, especially systems related to the preservation of water resources. Human intent to be greedier as long as their needs is fulfilled. Unaware of the future water crisis, the people tend to use all the resources excessively. This reality has made the efforts made by both the government and institutions useless. Corresponding to the level of pollution carried out by each individual is also increasing. Technology used by Indonesia to maintain the water resource is also very basic and not sophisticated, cause by limited capital cost and the absence of proper policy and regulation.

Policy and regulation of wastewater management in Indonesia still did not support the option of water reuse, and only emphasize safe discharge option. Dubious water reuse quality lead to difficult social acceptance regarding the health risk [10]. The human perception is really depending on their social backgrounds and become an unfortunate event for various culture country, lead to different and efficient strategy based on the area. Execution of water reuse cannot be separated from its quality. Policy and regulation became the major factor for institution to apply the water reuse technology. Every country with their different circumstances needs to decide the best option to execute the water reuse system. Until now, Indonesia does not have exact regulation about water reuse quality standard.

Ministry of Health of the Republic of Indonesia survey represent the prevalence of helmintiasis in Indonesia range from 40%-60% for all ages and 30%-90% for children [11]. According to USEPA, helminth categorized as parasites that can be excreted in feces as eggs, which is resistant to environmental burden such as desiccation, heat, freezing, and sunlight [4]. Due to their nature and impact on health, helmint eggs are one of the important parameters to be removed from water.

Irrigation water is vital point for better quality of crop that affect our daily intake of food. Current study shows the evidence of many contaminants in irrigation water. The contaminants consist of trace elements cause by the increasing use of wastewater that change the composition of irrigation water [12]. In this era, irrigation water source will exert substandard sources of water [12]. Poor quality of water is a source of contamination to crops [13] resulting to increased contamination of soil and water [14]. Morbid condition of irrigation water quality has awakened our consciousness about the effects of irrigation water quality on crops.

Water source for irrigation in Indonesia came from rainfall, river, or any surface water that can use to water the crop directly. Direct method to water the crop is to prevent additional budget for the farmer. Unfortunately, recent study shows the presence of helmint eggs in irrigation water in Sariwangi, Bandung reached up to 119.44 eggs/L [8]. Domestic waste water as the source of irrigation water is the answer for this frightening result. The presence of helmint eggs in irrigation water also resulting in the existence of helmint eggs in soil and crop sample [8]. The positive results, which is more than 1 egg/L in irrigation water, soil, and vegetables crop indicate the poor water quality based on guidelines from WHO for safe use of wastewater in agricultural activities [15].

Ascaris lumbricoides become the dominant type of helmint found in water, soil and vegetables with high infection rate in Indonesia [8]. Ascaris spp has widely used as indicator of helmint contamination since it is more persistent than other type of helminths [16]. Concern of health issue may rise since fertile egg may develop into worm in human body when accidentally ingested then causes Ascariasis.

Irrigation water as water reuse source without treatment will be a great disaster both for human and environment. The presence of helmint eggs in irrigation water will damage health quality an increased health risk [15]. The people who consume helmint eggs contaminated crops will have an infection. The plantation workers and family near the field will have an infection from direct contact with wastewater [8]. The assessment of helmint eggs has a major role to break the contamination chain.

Wastewater has become water resource due to its large quantities and its potential to be converted into valuable material [10]. Helmint eggs present in wastewater actually depends on several factors: prevalence of infections in surrounding communities, the size and socio-economic status of the population, and sanitation. WHO reported that high concentration of helmint eggs found in Iran and Brazil raw sewage has linear relation with the low socio-economic condition of the inhabitants [9]. Poor
housing and low water consumption per capita also contribute to high parasitic infection occur in community. This may be the answer why enormous number of helminth eggs detected in wastewater of developing countries [17]. In the area where open defecation is common or improper handling of sewage waste, helminth eggs can be released by infected individuals and start their life cycle in the environment. Wastewater irrigation contains helminth egg can be an effective transmission to infections [9]. It is because helminth egg does not require any intermediate host, the eggs require latent period of development in the environment, minimum infection dose, and this parasite not really affected by host immunity. *Ascaris sp.* or any other helminth egg are easily transmitted by the use of raw or insufficiently treated wastewater, therefore they are being the greatest public health concern in wastewater reuse scheme. Helminth eggs contained in wastewater normally are not infective since they need to develop larva such in soil or crops. In conclusion, polluted wastewater used in agricultural fields increasing the risk for human infection.

Helminth egg in wastewater basically is such particles forming a fraction of the suspended solids. Therefore, to remove helminth egg in wastewater the use of sedimentation, filtration, and coagulation-flocculation mechanism can be useful [18]. Actually, helminth eggs are normally removed from wastewater to be settled in sludge then inactivation sludge process was done [19]. Removal efficiency of helminth eggs for several wastewater treatment process has been reported at Table 1.

**Table 1. Removal efficiency of helminth eggs by selected wastewater treatment process [19].**

| Treatment Process                                      | Removal of helminth egg (%) |
|--------------------------------------------------------|-----------------------------|
| Waste stabilization ponds                              | 78 ± 99                     |
| Wastewater storage and treatment reservoirs            | 90 ± 99                     |
| Constructed wetlands                                  | 90                          |
| Primary sedimentation                                  | 0 - <1                      |
| Chemically enhanced primary treatment                  | 90 ± 99                     |
| Anaerobic up flow sludge blanket reactors              | 75 ± 96                     |
| Activated sludge + secondary sedimentation             | 85 ± 95                     |
| Trickling filters + secondary sedimentation            | 80 ± 90                     |
| Aerated lagoon or oxidation ditch + settling pond      | 85 ± 90                     |
| Coagulation/flocculation as tertiary treatment         | >99                         |
| High-rate granular or slow-rate sand filtration        | >99                         |
| Dual media filtration                                  | 99                          |
| Sand dunes infiltration                                | 100                         |
| Membrane bioreactors                                   | >99.99                     |
| Chlorination (free chlorine)                           | 0 ± 20                      |
| Ozonation                                              | 0 ± 20                      |
| UV irradiation                                         | 0                           |
| Photosensitized porphyrin                              | 90                          |

When adapting water reuse system as solution to save the clean water, the whole society must take a role to help the technology works. Government as the one who rule must make a decision and implement a policy and regulation regarding water reuse. This condition will coerce people to save the water and not polluting the water resource. Furthermore, government must provide a sufficient budget for this water reuse system, including the budget for quality examination both for the inlet and outlet of the system. Indonesian Government allocated an annual budget of around USD 31.1 billion for sanitation and hygiene sector in 2015, and it has been increasing to reach Goal 6 of the SDGs. Every country, is expected to realize 100% access to sanitation in 2030 [20]. Water treatment including water reuse technology can be use as alternative energy source. In some country, alternative energy can even be used by the surrounding community [21]. With the implementation of water reuse system, the processing costs will be lower, resulting in lower tariffs charged to the community [21-23]. The assessment of...
helminth eggs in inlet and outlet of water reuse system has a big help to remove the eggs which has the opportunity to develop and grow into parasites that endanger the health of another living things. Reduced number of helminth eggs in the environment lead to decreasing the possibility of infections, thus prevent the disease. The removal also will increase people acceptance to use the processed water from water reuse system. This condition will raise public awareness about the importance of conserving and recycling water.

4. Conclusion
Assessment of helminth eggs becomes major thing to be conducted in the application of water reuse. given the limited amount of clean water and the higher demand for clean water. Water reuse technology is also expected to help in removing the helminth eggs in the environment before reaching the host and cause disease. By removing helminth eggs in environment, helminth population will be decrease because the cut off of their life cycle. The parasite will be killed before reach their host and will reduce the percentage of helminthiasis. The collaboration between government, institutions and society is important to create an effective water reuse system for every people.

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References
[1] Asian Development Bank 2016 Indonesia: Country Water Assessment (Philippines: Asian Development Bank)
[2] Pawitan H and Haryani G S 2011 Ecohydrol. Hydrobiol. 11 231-243
[3] Liu J, Yang H, Gosling, S N, Kummu M, Flörke M, Pfister S, Hanasaki N, Wada Y, Zhang X, Zheng C, Alcamì J, and Oki T 2017 Earths Future 5 545-559
[4] U S Environmental Protection Agency 2012 Guidelines for Water Reuse (Washington, D.C.: U.S Agency for International Development)
[5] Muntalif B S, Firdayati M, Lesmono F D, Siregar A S V, Notodarmojo P A, and Fathuna I S 2020 E3S Web Conf 148
[6] Adanir R and Tasci F 2013 Food Control 31 2 482-484
[7] Ayres R M and Mara D D 1996 Analysis of Wastewater for Use in Agriculture: a Laboratory Anual of Parasitological and Bacteriological Techniques (Geneva: WHO)
[8] Firdayati M, Notodarmojo P A, Muntalif B S, Trihartomo D, Fathuna I S, and Somantri K 2018 Indones. J. Urban. Environ. Technol. 2 1 27-34
[9] World Health Organization 2004 Integrated Guide to Sanitary Parasitology (Amman, Jordan: WHO)
[10] Marleni N N N and Raspati G S 2020 JCEF 6 1 p 89-102
[11] Directorate General of Disease Control and Environmental Health 2009 Profile of Disease Control and Environmental Health in 2008 (Indonesia: Director General of Environmental Disease Control)
[12] Malakar A, Snow D D, and Ray C 2019 Water 11 7
[13] Singh S, Ghosh N C, Gurjar S, Krishan G, Kumar S, and Berwal P 2018 Environ Monit Assess 190
[14] IVOaP M A, RRPIü D ANbeU M A aQd RRPIü M 2018 Environ Geochem Hlth. 40 59-85
[15] World Health Organization 2006 Guidelines for the Safe Use of Wastewater, Excreta and Greywater (Geneva, Switzerland: WHO)
[16] Fidjeland J, Nordin A, Pecson B M, Nelson K L, and Vinnerås B 2015 Water Res. 83 153-160
[17] Gyawali P 2018 Water Sci. Technol. 77 4 1048-1061
[18] Jimenez-Cisneros B E 2006 Helminth Ova Control in Wastewater and Sludge for Agriculture Reuse, Water and Health (EOLSS, UNESCO)
[19] Jimenez B and Maya C 2007 Helminths and sanitation (communicating current research and educational topics and trends) *Applied Microbiology* (Formatex)

[20] I O Aujouanet Director 2017 *SDG Implementation in G20 Countries Status Spring*

[21] Gu Y, Li Y, Li X, Luo P, Wang H, Wang X, Wu J and Li F 2017 Energy self-sufficient wastewater treatment plants: feasibilities and challenges *Energy Procedia* p 3741-3751

[22] Garcia X and Pargament D 2015 *Resour Conserv Recy.* **101** 154-0166

[23] Guest J S, Skerlos S J, Barnard J L, Beck M B, Daigger G T, Hilger H, Jackson S J, Karvazy K, Kelly L, Macpherson L, Mihelcic J R, Pramanik A, Raskin L, Van Loosdrecht M C M, Yeh D and Love N G 2009 *Resour Conserv Recy.* **43** 16 6126-6130