REVIEW OF REGULATIONS AND POLICY FOR CIRCULAR ECONOMICS APPLICATION IN WATER AND SANITATION MANAGEMENT FOR CLIMATE RESILIENCE IN VIETNAM

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Abstract: *An essential responsibility in achieving the goals of water resource security strategies is efficient management, water-saving use, and water resource protection. In rural areas, the main issues were the high rate of inefficient water supply systems and water losses, as well as the fact that domestic water waste management is still out of control and water resources are contaminated. One of the causes was the absence of appropriate economic models that might guide the development of the water supply in a sustainable and effective manner. This essay discussed how circular economics could be used to manage rural water supplies. Reviews of the literature on policies, circular economics applications worldwide, and its adaptation in water supply management suggested potential circular economics principles for the water supply sector. They were 3R, which stood for Reduce, Re-use, and Recover. The incentive policy mechanisms for circular economics in water supply in Vietnam were not synchronized, and they were regulated in many relevant law documents. As a result, it was required to put forward a plan for rural water supply management based on the principles of the circular economy, which included developing scientific research, establishing regulations, and defining indicators for reducing, reusing, and recovering water resources.*

Keywords: *Circular economics, rural water supply, reduce, re-use, recover.*

1. INTRODUCTION

The effects of climate change-related water scarcity are becoming increasingly visible and have a significant impact on socio-economic activity (Nguyen Tung Phong, 2019). Particularly, there is a global water deficit in several areas. Around 2.3 billion people are thought to be affected by water scarcity, of which 733 million are assessed to be in extreme danger (UN, 2021). Meanwhile, water efficiency is only increasing at a modest rate, increasing by only 10% between 2018 and 2015 (UN, 2021). The threat of water scarcity appears to only exist during the dry season in Vietnam and might occur in particular river basins by 2030 (2030WRG, 2017). However, the water use efficiency is just one in ten when compared to the rest of the globe, and there is still roughly 30% water loss in the irrigation sector and 25.5% in the household water sector (Hoang Yen, 2020). Due to the internal exploitation of more than 25% of recoverable freshwater resources and up to 60% of the water amount in Vietnam's territory coming from neighboring countries, the risk of water shortage, especially in partial areas, is clearly visible, according to the new assessment approach of the World Bank in 2019 (World Bank). Particularly in 2023, there was a possibility of drought for 10,600–18,000

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hectares of cropland in Vietnam, and there was a partial water scarcity in the northern provinces (Department of Water Resources, 2023).

On the other hand, it is estimated that as the global middle class grows from 1.8 to 3.2 billion in 2020 and 4.9 billion in 2030, there will be a significant increase in consumer demand and pressure on the world's resources. As a result, using the linear economic paradigm of "take - make - dispose" causes the depletion of natural resources such as energy, raw materials, water, and nutrients. This necessitates a shift in production toward resource efficiency, reusing, and circular use. Water is regarded as one of the existing resources' key catalysts, acting as the process' central component and heart of this process. However, less than 5% of the world's water—the majority of it recovered wastewater—is repurposed. The linear economy will eventually be replaced by the circular economy (CE), which views water as a crucial resource for its guiding principles of recovery and regeneration (Veolia, https://www.veolia.com/).

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2. CIRCULAR ECONOMIC PRINCIPLES

2.1. Water circular principles

Circularity is regarded as a distinguishing feature of water in comparison to other resources because water quantity does not decrease during the use process but always fluctuates, changing its condition from "liquid, volatile, solid, and vice versa. However, water becomes limited in this process when the water quality changes and cannot be used for subsequent processes due to pollution or loss during exploitation and consumption. This necessitates ways to reuse or eliminate water loss, as well as saving, efficient, and proper water use. Figure 1 depicts the process of water circulation during use. Water will be temporarily provided to water-using sectors,

discharged and treated by nature or man-made means, or evaporated to begin a new cycle (Delgado et al., 2021) .

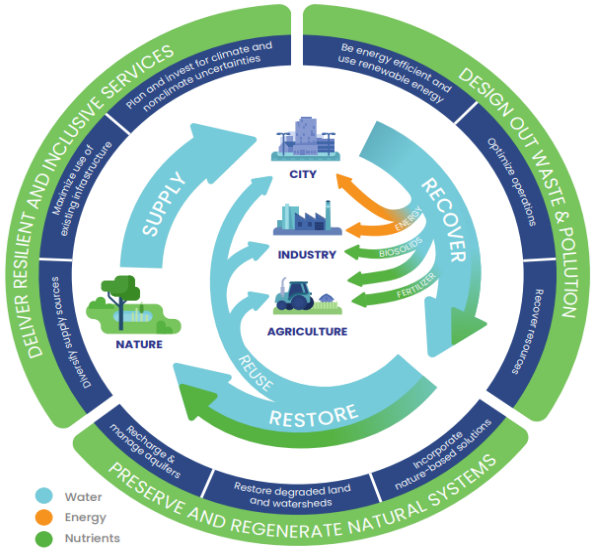

Figure 1: Water circular during the use process (Delgado et al., 2021)

When water is supplied to water users in a specific water use case, it is divided into two portions: (i) the useful water portion, which includes the portion that could be used to generate benefits and a small portion that does not generate benefits (water loss); and (ii) the unused portion (water loss), which includes the portion that can be continued to be used or reused if its quality remains (non-profitability) and the unusable portion due to water quality deterioration. As a result, in the process of using water, it is necessary to have solutions to recover quality water lost and to treat and restore deteriorated water for subsequent use processes in order to: (i) minimize the impacts on health and the environment; and (ii) maximize the beneficial and efficient use of water. When the CE principles are used, it is possible. However, economic, technological, and legal solutions are needed to make sure that water is used efficiently and to limit losses, inefficient parts, and wasteful portions (Figure 2).

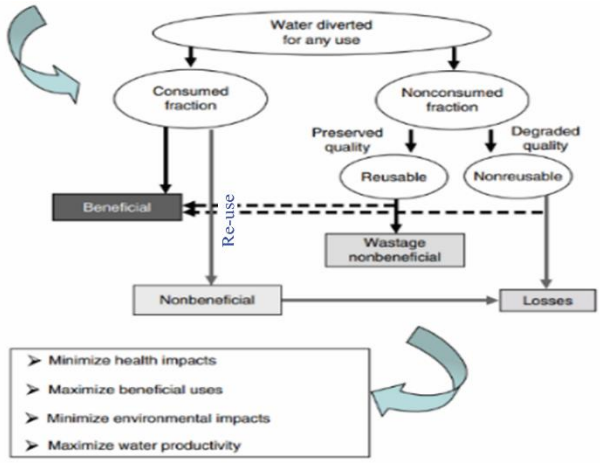

Figure 2: Flow chart of water use (Pereira et al., 2012)

2.2. Circular economy stratergies in WASH management

The circular economy, first proposed by Pearce and Turner (1990), is based on the idea that the outputs of past production procedures might all be repurposed as inputs for the next. This is defined as recycling or reusing tangible products and garbage as inputs in order to reduce the exploitation of natural resources as raw materials. Its fundamental objective is to use resources economically and efficiently, reuse or extend the life-cycle of outputs in a profitable manner, recycle, and make use of non-profitable outputs while maintaining a balance between environmental and economic aims. In accordance with the other viewpoints, CE is integrated management based on a combination of sustainable development and green growth in the context of preserving a finite natural resource base. CE differs in that it uses the material circulation process to boost economic, environmental, and social values while still ensuring income, profit, and environmental sustainability (Nguyen Danh Son, 2022; Vasileios Rizos, 2017). As a result, when transitioning from a linear economic model to CE, it is also necessary to promote or mobilize the participation of community institutions, market economic strengthening,

and government roles because they are the beneficiaries and also have an impact and are influenced when applying CE in practice (Nguyen Cong Thanh, 2022).

In fact, the CE principles that apply across sectors are the 10R principles: Refuse; Rethink. Repair; Refurbish; Remanufacture; Repurpose; Recycle; and Recover (Delgado et al., 2021). Water is a fundamental element in these concepts since it is an irreplaceable natural resource that occurs in all production sectors. It is also circulated in accordance with production cycles such as supply, manufacturing, and product consumption. Furthermore, water circulates through natural cycles such as "evaporation, condensation, and use."

In the water supply sector, water serves as both an input and an output factor in the fields of water supply and water treatment, containing both useful and unusable portions. Thus, employing the CE principles can indicate solutions that improve the efficient use of existing water resources, limit water losses, collect for reuse, and treat degraded water resources for the following water use activities. As a result, economic, social, and technical tools to raise awareness and responsibility for water resource use and protection are required, such as the use of advanced water treatment technologies and the restoration of water sources to ensure water resource quality that can be reused for future purposes (Mai The Toan et al., 2022). Many authors gathered and classified the 3 Rs (Reduce, Re-use, and Recover) in the field of water supply based on the chemical, biological, and physical cycles of water and collaborating with CE principles. And its cycle range is determined by the water use characteristics of several economic sectors, such as water use or consumption (ING Bank, 2017), specifically as follows:

R1. Reduce - decrease in water demand. For the agricultural sector (irrigation sub-sector), it is necessary to employ effective irrigation measures, improve the water usage effectiveness of existing crops, and use drought- and salt-resistant crops. For industrial sectors (home water supply), it is essential to monitor operations to avoid water loss, to employ advanced water filter equipment efficiently, and to optimize manufacturing and delivery processes to reduce water loss. For a decrease in household water use, it is necessary to employ water-saving equipment and technology, as well as adjust water-use habits and lifestyles. To reduce water pollution, it is necessary to use water properly in order to avoid contamination, such as by constructing distinct water management systems for dirty and pure water.

R2. Re-use - Reuse and clean water: Reuse grey water for other purposes; treat and reuse home wastewater containing heavy metals; purify water through biological cycles in the natural water cycle...

R3. Recover - Water recovery includes the development of natural infrastructure such as wetland regions and forests for long-term water retention, lakes for rainwater storage and groundwater recovery, and improved agricultural land protection.

2.3. Lessons learnt of foreign countries

Many countries have used CE principles in establishing their own comprehensive strategies and tools for water service supply management, including economic, social, and technical instruments. Technical instruments frequently focus on solutions such as water treatment and water-saving consumption objects; society is to raise awareness towards improving attitudes towards saving water use and protecting the environment; and economics-management is to use management measures to perfect the managerial model;

economics is to adopt financial instruments such as water taxes, tariffs, and so on to increase accountability, responsibility, and water-use behavior towards saving water use. They were highly effective in boosting water-use efficiency and decreasing water loss and pollution. Currently, a number of countries throughout the world are pioneering the use of CE principles as a foundation for master plan development (Table 1). The outcomes have had distinct effects on us. For example, the European Union has cut overall raw fuel demand by 17% to 24%, increased GDP, and produced 1.4 to 2.8 million jobs (Bernd Meyer, 2011). Table 1 shows that the six research areas have saved 412 million cubic meters of water per year, which is equivalent to the total water consumption of the United States per year and 11% of global water demand (ING Bank, 2017).

CE is defined in Vietnam as "an economic model in which design, production, consumption, and service activities are aimed at reducing the extraction of raw materials, prolonging the life-cycle of output products, limiting waste generation, and minimizing adverse environmental impacts" (Nguyen Dinh Tho, 2022). Typical models such as the gardening economy, household-sized wastewater treatment, livestock wastewater recycling, and so on have been established.

Table 1: Application of CE in water supply of some countries in the world
(ING Bank, 2017)

CE principles	California, US	Ghana	Bangladesh	North India	Holland	Arabic Saudi
Reducing water demand in agricultural sectors	Water saving and efficient irrigation and drought resistant cropping		Sustainable groundwater extraction and irrigation technologies	Irrigation methods and groundwater extraction	Satellites and salt resistant cropping	Efficient water use awareness
Reducing water demand in industrial sectors	Technologies	Reducing water loss				Sustainable water use
Reducing home water consumption	Water saving habit and technologies		Water treatment	Recycling wastewater	Water saving habit and technologies	Lifestyle
Reducing water pollution		Mineral exploitation, pesticides, home water waste	Water treatment technologies		Antibiotic and organic elements from production	
Re-use and treatment of water	Re-use of wastewater and preserving water underground	Re-use of wastewater		Re-use of wastewater		Re-use of wastewater

Recovery - generation	Recover the aquifers	Regenerating water in manmade water aquifers	Storing raining water in the acquirers

3. NATIONAL REGULATIONS AND POLICIES ON CE OF VIETNAM

3.1. General regulations on CE for water supply management

(1) General regulations on CE in Vietnam

Item 11 of Article 5 of the Law on environmental protection No 72/2020/QH14 mandates all sectors to include CE in their respective master plans and strategies for socioeconomic development. Article 142, in particular, establishes certain broad principles of CE in the exploitation and use of raw materials, the limitation of waste disposal, and the greatest elimination of negative environmental consequences. All ministries and sectors actively utilize the CE principles when developing and executing action plans to efficiently manage and use natural resources, decrease waste, and increase waste re-use and recycling levels. As a result, the government establishes criteria for evaluating certain degrees of CE application as well as its practice. Then, sectors that use a large amount of water resources, such as agricultural production and water supply, must implement policies that encourage the use of new innovation models and production plans geared towards sustainability and climate change adaptation, water conservation, and water and waste water reuse for other purposes in order to ensure environmental issues are addressed.

In 2022, degree 80/2022/NĐ-CP was issued and provides detailed advice for various provisions in the Law on environmental protection, notably Article 142, which requires clarification of the criteria, roadmaps, and incentive mechanisms for developing CE in Vietnam. They include broad requirements for decreasing exploitation and enhancing the efficiency with which water resources are used, as well as sewage restrictions. To achieve these objectives, relevant ministries at all administrative levels must implement CE strategies in accordance with their functions and tasks, including the establishment of mechanisms to promote CE application, such as scientific research, the sharing of information and data on CE development, etc.

(2) Water Resources management

The Law on water resources No. 17/2012/QH13 includes a chapter on the effective exploitation and use of water resources. As a result, it indicates the need to adopt advanced economic-technical measures in water extraction and use towards circulation and re-use; the need to develop policies that encourage, regulate, and limit water loss and waste in water supply systems, such as stable, safe, continuous water supply; and the maximum reduction rate of water loss and waste (Article 40). Similarly, the law addresses incentives and promotion of innovative scientific and technical models for circular water usage, efficiency, recycling, reuse, rainfall gathering, and use (Article 41).

For sustainable water resources management and use, the government issued Decision no 622/QĐ-TTg in 2017 with the purpose of setting out the objectives of facilitating and enabling people to access clean, safe water and their payment affordability, with a particular emphasis on women, children, and vulnerable groups. Goal 6 establishes the milestones to be met in order to reduce degradation of the environment and water resources: 100% of homes have sanitation facilities; 100% of wastewater is treated and reused safely; boosting water efficiency in all sectors; and extracting water when authorized. Protect and restore water-related ecosystems by 2030. The sub-goal 6.4.2 additionally displays the extent

of water scarcity based on the ratio of fresh water used to the total fresh water available. This is to determine how much fresh water is extracted for commercial purposes versus how much fresh water is retrieved to stabilize the ecosystem.

(3) CE development plan in Vietnam

In 2022, Decision no 687/QĐ-TTg of the Prime Minister approved CE development projections in Vietnam. The specific goals are to improve the recycling ability of 70% of organic waste in rural areas by 2030, thereby improving local life quality and resilience to climate change. Based on the aforementioned objectives, the ministry of agriculture and rural development, like other ministries, finalizes its own legal framework for CE development in agriculture and rural sectors in accordance with targets of efficient water resource use and reduction of water resource degradation and environmental pollution through the sector's CE programs, including the suggestion and proposal of CE activity implementation by each commune.

To conduct the social-economic plans according to CE principles, the government is proposing a national action plan on CE implementation. The goal is to maximize resource value, reduce waste, regenerate resources to maintain a sustainable environment, and respond to climate change, all while focusing on resource management and environmental preservation. As a result, national CE standards, such as those minimizing exploitation and boosting water resource efficiency, have been developed. Agriculture is the second preference point, while water supply and treatment are the seventh on the national CE implementation list. The answer begins with a shift in mindset, followed by the implementation of CE models centered on the optimal use of water resources and the improvement of institutions and policies. The following are the proposed CE implementation criteria:

- Water resource use (Criteria A1.4) consists of the following components: (1) water resource consumption norm (water consumption per output unit or GDP); (2) water resource use efficiency (water consumption/GDP, value-added units of the industrial sector, and major industrial output units); and (3) rate of water saving use application model.

- Water resource efficiency (Criteria A1.7) comprises (1) the amount of water consumed per GDP; (2) the amount of water consumed per value added unit of the industrial sector; and (3) the amount of water consumed per output unit of the major industrial sector.

- Water reuse (Criteria B.14): includes the utilization rate of reclaimed waste water in accordance with national technical requirements.

- Sewage reduction (Criteria C.16): the rate of wastewater collected and treated in line with national technical requirements.

3.2. General regulation of rural water supply management matching to CE

(1) Directives in rural water supply management closing to CE principles

Security of water resources is regarded as a top priority, along with dam and reservoir safety, because they function as essential and irreplaceable material sources for the objectives of sustainable socioeconomic development. The Conclusion of Political Bureau No. 36-KL/TW from 2022 identified the major concerns that needed to be addressed up to 2030 and the overall vision for 2045. By 2025, 2030, and 2045, respectively, 60%, 80%, and 100% of rural households are expected to have access to standardized water. Accordingly, there are levels that may be reached for successfully overcoming, resolving, and regulating pollution, degradation, and depletion of water resources; responding to natural disasters; and addressing climate change with the goal of ensuring the security of water supplies by 2045. As a result, there are a number of top priorities for tasks that will lead to the efficient and economical use of water, including increasing

awareness, enhancing institutional water security policies, actively storing water, balancing water distribution, and meeting societal water demands through restructuring major water use sectors; adopting water-saving and water reuse solutions; strictly monitoring water uses; reducing water losses and overuse; and implementing water-saving and efficient use measures in various contexts.

In order to ensure the security of water resources, dams, reservoirs, and vision by 2045, a number of action plans were issued, including one to implement Conclusion no. 36-KL/TW (Decision no. 1595/QD-TTg) and another to specify the goals and mandates of the various ministries and sectors.

The government released Decision No. 1978/QD-TTg authorizing the national plan for rural WASH up to 2030 and vision by 2045 in order to utilize water resources effectively and sustainably, along with fulfilling the home water demands of rural residences with social welfare. The fundamental objective was to guarantee that every rural household could access standardized water resources and obtain public sanitation services at the home and social scales. 65% of rural people will utilize standardized water by 2030. Accordingly, the sanitation sector is expected to accomplish 25% of central rural areas having wastewater collection systems by 2030 and 15% of wastewater being treated by 2045, respectively.

The decision calls for relevant ministries and sectors to create a proper roadmap for implementing the full cost recovery of rural water tariffs, which will serve as a starting point for regulating people's behavior in water-saving use while also creating policies for the poor to access clean water. This is necessary to ensure effective operational and maintenance management of the rural water supply structures. There were rapid and efficient solutions that might guarantee the timely delivery of water to those affected by climate change, natural catastrophes, and diseases. Water kiosks or water ATMs that give affected individuals access to direct drinking water are a good example in practice. For improved investment efficiency, sustainable structures, and a sustainable water supply, the operational and maintenance management of rural water supply structures must be integrated between the pre- and post-construction phases. It is important to encourage the integration of small water systems into large-scale water delivery systems in order to ensure effective, sustainable operations, water security, and resistance to climate change. The solutions also include establishing monitoring and warning systems for water quality and quantity for daily needs, reducing water pollution for a safe water supply and climate change adaptation, and engaging the community in the management and protection of the structures that provide water and treat and collect wastewater in accordance with the rules, as well as transferring rights for local people like "awareness, discussion, doing, examination, and beneficiaries" with the technical assistance of experts.

(2) Sustainable and efficient rural water supply management and use

In 2010, the government released Decision No. 2147/QD-TTg, which outlined the national plan on water loss prevention up to 2025, in order to address effective issues in rural water supply management and water-saving use. The main goals of the contents are to direct and mobilize resources for water loss prevention activities through institutional and policy improvement, capacity building, and monitoring the implementation of technical solutions to minimize water loss due to technical reasons. By 2025, it is intended to have decreased from 30% on average in 2009 to less than 15%.

In 2022, the MARD also published Circular No. 23/2022/TT-BNNPTNT to help implement safe water provision for piped water supply systems in rural regions. This was in reference to the sustainable rural water supply management objectives. The major goal of the circular is to establish standards for the oversight and assessment of O&M management of buildings

and the provision of water services to consumers in order to reduce and ultimately eliminate dangers and risks that might result in water scarcity. Their effects will include a reduction in water loss rates, water conservation, environmental protection, and a move toward water tariffs that will cover all costs and accumulate benefits for fixing minor issues and rehabilitating structures. Rural household structures and piped water supply systems with capacity scales of at least 100 m^3/h day-night are among the affected topics.

3.3. Rural water supply management resilience to climate change

The government released Decision No. 1055/QD-TTg in 2020 on a national strategy for climate change resilience in the period of 2021 to 2030 and a vision by 2050 to address extreme weather phenomena in response to the negative effects of fluctuations in weather that endanger the rural water supply objectives. The average annual temperature has risen by around 0.62°C over the past 50 years, the sea level has risen by roughly 3.34 mm/year between 1993 and 2014, and the frequency and severity of natural catastrophes have also increased. The government has developed a number of adaptative plans in response to this situation, including building community capacity, the economy, and ecosystems through investments in resilient activities, scientific and technological plans, raising awareness to change behavior, and resilient communities. In particular, it means providing priority to areas that may be at risk for drought, water shortages, and the negative effects of saline intrusion. It also includes more effectively managing, monitoring, and protecting water resources in the context of climate change. Activities that are expressed through programs and projects include things like increasing the capacity for managing, monitoring, and protecting water resources, boosting water storage capacity, and improving water use efficiency. Intercropping models that are suitable for draught conditions and climate change adaptation are also being spread and multiplied.

4. CONCLUSION AND RECOMMENDATION

The circular economy is founded on the principles of sustainable development and green development and is considered an unavoidable tendency of social development. In reality, several nations have incorporated the CE principles into their own strategies for socioeconomic growth and have had positive outcomes. The Law on environmental protection of Vietnam (Article 142) contains an article regulating CE development as well as various reference materials under the law. Its effects are evident in the nations that have implemented CE for environmental protection, increased employment, and GDP. Additionally, CE is used in a variety of sectors since water is essential to many production processes, serving as both primary and auxiliary components.

Water is both an input and an output that come in both usable and unusable forms for the water delivery industry in general and rural regions in particular. It changes in accordance with both the rules of regular manufacturing procedures and the characteristics of natural circularity, making CE application imperative. However, CE laws and policies are still fragmented among several legal instruments, particularly when it comes to the manufacturing and domestic water supply sectors. The findings of this study first pointed to three major R concepts—reduce, reuse, and recovery—as viable CE principles. However, the precise legal requirements of CE for the water supply industry have not been thoroughly analyzed in accordance with national environmental laws and positive CE traits. Based on this, it is suggested that research and incentive legal frameworks be developed for CE application in the rural water supply sector.

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