

## Pathways toward Water Sensitive Cities: An Educational Approach through Geography Learning

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### ABSTRACT

The 2030 Sustainable Development Goals (SDGs) have seventeen global goals for the sustainability of human life on planet Earth. One of these goals is to ensure access to water and sanitation for all. This article aims to formulate a grand design of Geography learning as part of social studies taught in the school. The context of the research is the east coast of Aceh Province. The research method used in this paper is a systematic literature review through books, scientific journals, and reports from several community-based water development programs. The grand design is formulated within ten years with three phases, namely (1) Acceleration; (2) Evaluation, and (3) Sustainable Education. The results of this literature review are expected to contribute to the management of water resources in the coastal area of East Aceh while at the same time increasing the implementation of the Merdeka Belajar (Independence Learning) policy at every level of education that is oriented toward local natural resources.

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## 1. INTRODUCTION

The world faces extreme climate change, resulting in an unstable hydrological cycle and an increasingly difficult clean water supply (Afrian & Islami, 2018; Hoffmann et al., 2020). The Sustainable Development Goals (SDGs) for 2030, set by the United Nations, encompass a comprehensive framework for global development. Among these goals, Goal 6 specifically targets clean water and sanitation. This goal aims to ensure universal access to safe and affordable drinking water, as well as adequate sanitation and hygiene for all. The community's need for water resources is increasing because water is a resource that is closely related to all human activities. Limited water resources significantly impact the sustainability of human life and other living things worldwide (T. Wong et al., 2013). In the context of sustainability, limited water resources have ecological, social, and economic impacts. Ecologically, limited water resources can lead to a decrease in biodiversity. On the social aspect, limited access to clean water can hinder people's ability to meet their basic needs, such as drinking, washing, and cooking (Rogers et al., 2020). From an economic perspective, limited water resources can seriously impact the agricultural, industrial, and tourism sectors. This shows that the availability of clean water is critical in all aspects of human life and other living things.

Access to clean water is pivotal in social studies education. It exemplifies the intersection of geography, economics, and human rights. Geographically, it influences settlement patterns, shaping communities and civilizations (Meiryani et al., 2022). Economically, it impacts livelihoods, agricultural practices, and industrial development (Jiang & Rohendi, 2018). Moreover, clean water is a fundamental human right, underscoring civic responsibility and governance (Moosavi et al., 2021). Studying water access fosters global awareness, emphasizing interdependence and environmental stewardship. Thus, integrating clean water issues into the social studies curriculum not only enriches academic understanding but also cultivates informed, socially responsible citizens attuned to the intricate web of human societies and their natural environments. However, this paper will be focused on geography learning as part of social studies in school.

The context used in this paper is the east coast of Aceh Province. The coastal area of East Aceh consists of three administrative regions, namely East Aceh Regency, Aceh Tamiang Regency, and Langsa City. This area is located on the east coast of Aceh, which faces serious challenges related to the availability of clean water for its people. The East Aceh Coastal Area has dominant characteristics in the form of lowlands and swamps (Fathanah et al., 2020). A flat topography characterizes this area; the majority is located along the coastline, with most of the land comprising lowlands formed by sediment deposition processes. These lowlands have relatively low elevations and are below sea level (Sarker et al., 2019). Due to its low altitude, this area often experiences a high risk of flooding, especially during the rainy season with heavy rainfall (Mutia et al., 2020). Even though it is surrounded by water resources such as rivers and seas, the low availability of clean water threatens people's health and daily life. This can be caused by two main factors: natural and human factors.

Natural factors consist of morphological conditions and the location of the East Aceh coastal area. Low morphological conditions and proximity to the coast can significantly influence groundwater conditions in the area (Bharath et al., 2021). Areas with common morphological conditions and coast proximity are vulnerable to saltwater intrusion. Saltwater intrusion occurs when seawater or saltwater contained in aquifers infiltrates into the deeper layers of groundwater. The difference in hydrostatic pressure between groundwater and seawater causes this. Saltwater intrusion can reduce groundwater quality, making it unfit for consumption or irrigation. Low morphological conditions and proximity to the coast also

increase the risk of flooding in coastal areas. Flooding can cause a significant increase in groundwater levels, especially when existing drainage channels cannot drain water effectively (Afrian, 2020). As a result, abundant rainwater can seep into the ground quickly, affecting the quality and availability of groundwater in the area.

Meanwhile, the human factor is the low quality of clean water management in the coastal area of East Aceh. The community must be aware and knowledgeable about clean water management's importance (Slapničar, 2019). With great attention, people are likelier to promote good water management, such as saving water, wise use, and participation in water conservation programs (Rogers et al., 2020; Sharp et al., 2022). Community active participation can also strengthen efforts to manage clean water through better supervision and monitoring practices that can affect the availability of clean water (Albanah et al., 2023). If humans do not use water wisely and efficiently, the availability of clean water can be negatively affected. Excessive water use and wastage can deplete limited water resources, cause groundwater depletion, and disrupt the balance of aquatic ecosystems. Therefore, effective management and appropriate conservation measures can maintain the availability of clean water in the long term (Brown et al., 2016).

The education sector is an essential component of sustainable development, especially in social studies and geography. The younger generation must be educated and trained to face the challenges of an increasingly high and competitive future. Education can provide communities with theoretical knowledge and practical skills to manage water resources efficiently and sustainably (Farrelly et al., 2019; Ramirez-Lovering et al., 2019). Through educational programs that cover aspects such as saving water, efficient irrigation techniques, waste management, and improving water quality, communities can learn how to use water resources wisely without compromising long-term sustainability. Education can also educate about the importance of prioritizing clean water needs for the community, especially in conditions of limited resources (T. H. F. Wong et al., 2020).

In addition, education can help develop a deeper understanding of the importance of sustainability and build awareness of collective responsibility in managing water resources (Avazpour et al., 2023; James et al., 2023). Education can promote better collaboration between government, civil society, and the private sector in addressing water resources management challenges through learning that engages the community, stakeholders, and relevant institutions (Cai, 2008; Yani & Mulyadi, 2022). This can involve concerted efforts to develop sustainable policies, practices, and innovations and build local capacity to manage water resources effectively.

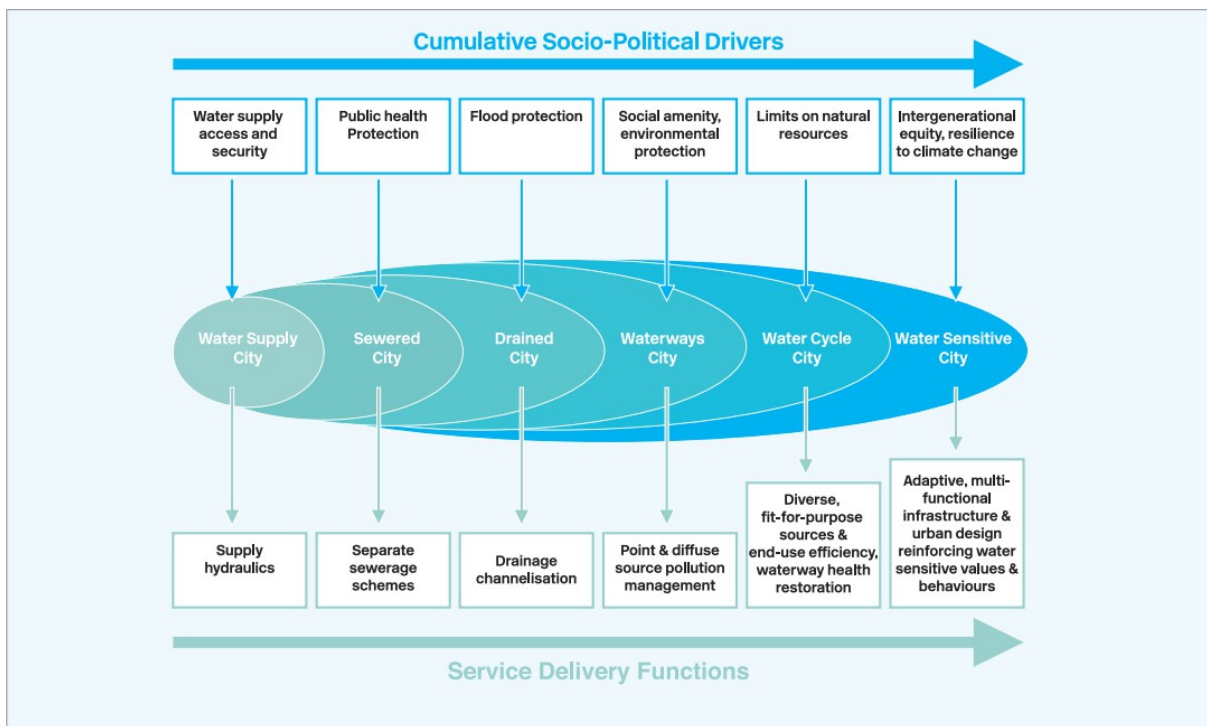
Monash University is a leading university in Melbourne, Australia, focusing on sustainable water resources management. Water Sensitive Cities (WSC) is a concept initiated by Monash University to manage water resources in major cities in Australia and the world (ADB & RISE, 2021b, 2021a, 2021c). Even Monash University has implemented the WSC concept in Indonesia, precisely in Makassar City, through the RISE (Revitalizing Informal Settlements and their Environments) program. This program is carried out to normalize the use of water resources in slum areas in Makassar City (ADB & RISE, 2021c; Ramirez-Lovering et al., 2020). This program has achieved this goal through comprehensive educational efforts involving all societal elements. This article aims to analyze the WSC concept and the RISE program, then formulate it as an educational grand design on the east coast of Aceh. Through the formulation of the grand design, it is hoped that it can help stakeholders and elements of education, especially universities, to contribute to the sustainable management of water resources on the coast of East Aceh.

## 2. LITERATURE REVIEW

Geography is essential in implementing the Water Sensitive Cities (WSC) concept. Geographical conditions of an area, such as topography, climate, and soil type, can influence the approach used in water management (Yani & Mulyadi, 2022). For example, an area prone to flooding may need a robust flood protection infrastructure, whereas a room with a limited water supply may need to focus on wastewater reuse. In addition, geographical characteristics can also affect the ability of an area to implement green infrastructure such as rain gardens or retention ponds (Balasooriya et al., 2023; Henriques et al., 2015). Therefore, a deep understanding of the geography of a site is vital in designing solutions that suit each city's unique needs in creating a WSC.

Geography learning at universities in the context of Water Sensitive Cities can be implemented by introducing concepts, theories, and practices related to sustainable urban water management (Yani & Mulyadi, 2022). Students can study water resource mapping, hydrological modeling, climate analysis, and urban planning that are responsive to water. They can also learn about innovative technologies used in water management, such as monitoring sensors and water monitoring systems. This course will provide a deeper understanding of the challenges and opportunities associated with Water Sensitive Cities and provide the necessary skills to contribute to designing and implementing sustainable solutions in urban water management (Sharp & Raven, 2021).

Water Sensitive Cities (WSC) is a concept developed by Monash University to address the challenges faced by cities related to the lack of availability of clean water for the community. This concept aims to produce environmentally sustainable cities, efficient water use, and responsiveness to climate change (Melbourne Water, 2013). WSC integrates urban planning, water resources management, environmental design, and community education. Complete literature on this concept can be accessed on the web page <https://watersensitivecities.org.au/>. One of the main principles of the WSC is nature-based water management. Humans must manage water according to the fundamental nature of natural objects such as rivers, lakes, or waterways in cities to make water management efficient. For example, they use a rain harvesting system by planting rain gardens, rainwater harvesting, or retention ponds. Reusing wastewater is also a focus of this concept, using the right technology to process wastewater into clean water that can be reused for non-potable needs. The urban transition to water sensitive cities can be seen in Figure 2.



**Figure 1.** Urban water transitions from conventional approaches of water supply and sewerage to water-sensitive cities (ADB & RISE, 2021c).

In addition, WSC also encourages the development of intelligent and innovative infrastructure. This includes using technology to measure and monitor water quality and quantity within cities accurately (Rogers et al., 2019). Water management decisions can be taken effectively and promptly with the data collected. In addition, developing green infrastructure such as green roofs, parks, and corridors is also emphasized to increase water infiltration into the ground and reduce runoff. Water Sensitive Cities also invite active community participation in water management (Raven et al., 2021). Public education and awareness of the importance of sustainable water management is a crucial factor in the success of this concept. Through participatory programs, such as water-saving campaigns or self-management of water within the community, awareness of the importance of wise water use can be increased. The focus of the study in this article is educational efforts to create Water Sensitive Cities.

Many parties have carried out educational efforts to build a water-aware society. One program that has succeeded in making this awareness is the RISE project organized by Monash University in Makassar, Indonesia (<https://www.rise-program.org/>). The RISE (Revitalizing Informal Settlements and their Environments) project provides essential lessons about revitalizing water resources for slum settlements. This project aims to increase the access of urban communities living in slum areas to safe and sustainable water sources and reduce negative impacts on health and the environment. One of the essential lessons that can be learned from the RISE Project is the importance of collaboration between universities, government, communities, and other stakeholders. Monash University works with local governments, NGOs, and communities to identify problems, design solutions, and implement water revitalization programs. This collaboration enables different stakeholders to share knowledge, resources, and expertise, thus strengthening project implementation and ensuring its sustainability.



In addition, the RISE Project emphasizes the importance of a participatory approach in addressing water resources issues. Local communities are empowered to play an active role in implementing, implementing, and maintaining applied water solutions (Cui et al., 2019). Through their involvement, the community feels they own the project and can better maintain its sustainability. This empowerment includes training in water management, participation in decision-making, and forming community groups tasked with maintaining and overseeing the new water infrastructure. Furthermore, the RISE Project demonstrates the importance of a holistic approach to revitalizing water resources. In addition to providing safe and sustainable access to clean water, this project also pays attention to sanitation and environmental hygiene. Environmental education and awareness programs are carried out to change people's behavior regarding sanitation and water hygiene. This is important in reducing the risk of disease associated with contaminated water and creating a healthier environment.

Equally important, the RISE Project demonstrates the need for a sustainable and community-based approach to revitalizing water resources (ADB & RISE, 2021a). Monash University builds new infrastructure in this project and develops community capacities in operating, maintaining, and financing water solutions. By involving the community in the planning and implementation stages, the project better understands community needs and expectations, resulting in more relevant and sustainable solutions (Cui et al., 2019).

A critical aspect of implementing the RISE project is the implementation of the principles of co-design and co-benefit (ADB & RISE, 2021a). The principle of co-design and co-benefit is a collaborative approach to managing water resources that involves the active participation of various stakeholders and aims to achieve mutual benefits. The co-design principle refers to a process involving stakeholders actively designing water resources management plans and policies. In this approach, not only the government or technical experts have a central role in decision-making, but local communities, community groups, non-governmental organizations, and the private sector are also actively involved. The co-design approach aims to achieve more inclusive decision-making, consider local knowledge, community needs, and aspirations, and ensure wider acceptance and support for the resulting plans and policies (ADB & RISE, 2021a).

The principle of co-benefit relates to efforts to achieve mutually beneficial results for the various stakeholders involved in managing water resources. This approach recognizes that water resources management is about achieving ecological sustainability and considering social, economic, and cultural interests. In the co-benefit-based management of water resources, efforts are made to identify and implement solutions that can generate simultaneous benefits for the parties involved (Brown et al., 2016; Ramirez-Lovering et al., 2019). For example, a water resources management project could be designed to meet water needs for agriculture, improve access to clean water for local communities, and conserve essential river ecosystems.

By applying the principles of co-design and co-benefit, the management of water resources can become more inclusive and sustainable and positively impact various stakeholders. The co-design process ensures that various perspectives, knowledge, and interests are considered, making the decisions more representative and widely accepted. Meanwhile, the principle of co-benefit helps identify and implement solutions that can meet the needs and expectations of various stakeholders, thus creating diverse and sustainable benefits for all parties involved in water resources management.

Overall, the RISE Project by Monash University in Makassar provides valuable lessons in revitalizing water resources for slum settlements (ADB & RISE, 2021c). These lessons cover the importance of collaboration between stakeholders, participatory approaches, holistic approaches, and sustainable and community-based approaches. Considering these lessons, we can develop strategies and solutions that are more effective in dealing with challenges related to water resources in slums and ensure long-term sustainability.

### 3. METHOD

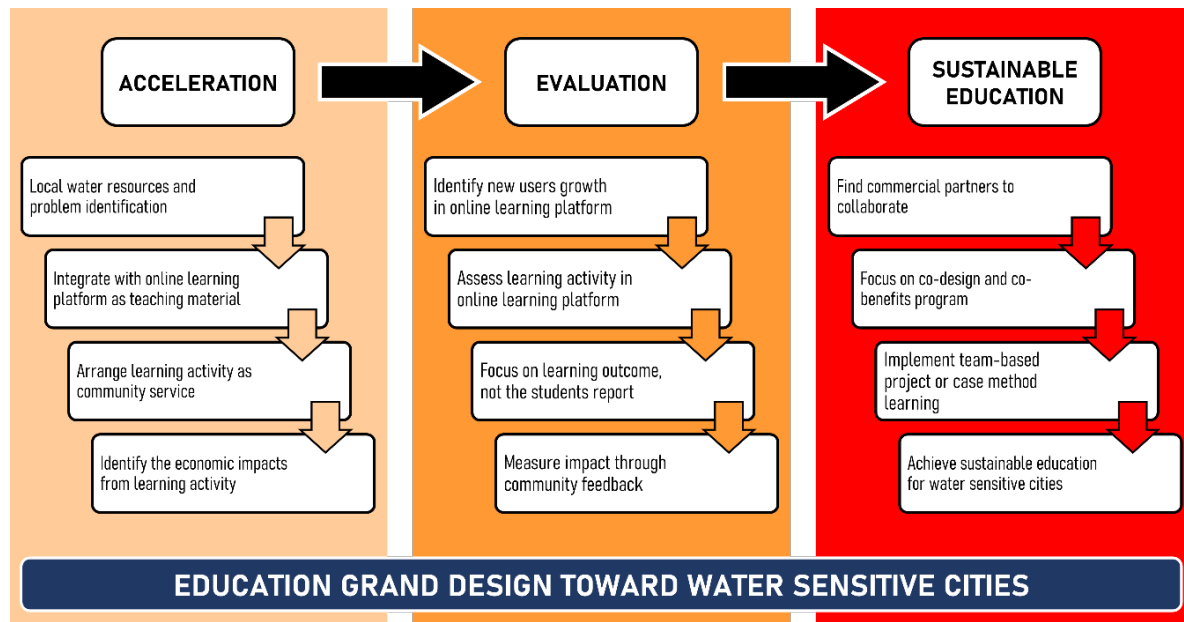
The method used in this research is the literature review. A scientific literature review is a thorough analysis and synthesis of existing scholarly research on a specific subject or research question. It involves a systematic search for relevant academic sources, such as peer-reviewed journal articles and books, to understand the current state of knowledge in a particular field (Arlene, 2019). The process begins with defining the review's scope and objectives, followed by a comprehensive search for pertinent sources. Each source is rigorously evaluated for quality and relevance. The literature is then organized based on chosen criteria, and sources are analyzed for key findings and methodologies. Patterns, trends, and gaps in the existing literature are identified. The review is presented with an introduction contextualizing the topic, followed by detailed discussions of each group of sources. It concludes by summarizing key insights, suggesting areas for future research, and emphasizing the significance of the reviewed literature (Boland et al., 2017). Proper citation of sources is crucial throughout. A well-executed literature review provides a foundation for further research, demonstrating the researcher's familiarity with the existing body of knowledge in their chosen field of inquiry.

### 4. RESULTS AND DISCUSSION

Based on the literature review in the previous section, the educational grand design of Water Sensitive Cities on the east coast of Aceh can be categorized into three phases, namely (1) acceleration, (2) evaluation, and (3) sustainable education. The first phase, acceleration, involves accelerating public awareness and understanding of the importance of water-sensitive cities. Education must be a strong foundation for building this awareness. It should be conveyed that the context in this article is an educational grand design in a tertiary institution. This is due to the flexibility of tertiary institutions to formulate their learning curricula independently. The grand design of the education scheme for the east coast of Aceh towards Water Sensitive Cities can be seen in Figure 2.

To accelerate WSC achievement in the educational grand design, this can be started by identifying local water resources and their problems. Local water conditions include the availability of raw water from rivers, lakes, or groundwater in the eastern coastal area of Aceh. This identification effort can be a good start to identifying local water potential that can be utilized. The identification results can be compiled into data packaged as teaching material. After that, the teaching material can be presented through an online learning platform. In the era of society 5.0, where artificial intelligence is accelerating, the need for online learning through online platforms is unavoidable. Therefore, online platforms are highly recommended to accelerate geography learning at universities towards the east coast of Aceh as a future WSC. In the context of social studies learning, Goal 6 - clean water and sanitation - serves as a multifaceted educational tool. Firstly, it provides a tangible example of the interconnectedness of global issues. Access to clean water is not isolated; it is intertwined

with environmental sustainability, public health, and socio-economic development. By studying Goal 6, students gain a holistic understanding of how various aspects of society, economy, and environment are interdependent. Furthermore, Goal 6 is deeply rooted in geography education. It highlights spatial disparities in water availability, showcasing how geographical factors such as climate, topography, and proximity to water sources impact communities differently. This geographical perspective is crucial for comprehending regional inequalities and their social implications.



**Figure 2.** Educational grand design on the east coast of Aceh towards Water Sensitive Cities (WSC).

After that, learning geography must be packaged as community service so that students can learn directly from the community and other learning resources comprehensively (Jones & Walker, 2019; Yani & Mulyadi, 2022). This effort is significant to bring them closer to the actual problems that occur in society in terms of scarcity of water resources. Community services carried out by students also need to identify their impact on society, especially in the economic aspect. Community service must be able to improve the welfare of local communities. This is because water resources are essential in supporting community economic activities. Students will interact directly with the community to learn to control problems and seek relevant and contextual solutions. Economically, clean water access is an essential driver of prosperity. It underpins agricultural productivity, industrial growth, and overall economic development. Understanding the economic dimensions of clean water supply through Goal 6 fosters critical thinking about resource allocation, trade-offs, and sustainable resource management, which are fundamental concepts in social studies.

The second phase is evaluation. The evaluation phase is the impact measurement phase of the acceleration efforts (Marvell & Simm, 2018; S. K. Milligan & Griffin, 2016). The online learning platform developed at the accelerated stage can be an effective and efficient measurement tool. Online learning platforms can collect behavioral data from each website user. The most important thing that can be measured is the growth in the number of users, user activity on the platform, and feedback from the community as the activity target. In addition, the university must prioritize learning outcomes over student reports. This effort



aims to prevent students from being biased by the burden of reports that do not significantly impact achieving WSC goals on the east coast of Aceh.

The east coast of Aceh is one of the areas with the lowest economic growth in Aceh Province. This shows that education has not significantly impacted their economic activities. Therefore, Outcome-based Education, or OBE, is highly recommended to be implemented here. As a substitute for student reports that are not made, lecturers can assess learning achievement through verbal presentations supported by photos and videos of activities. Of course, this is easier to do, considering that photo and video processing platforms are already widely used on Android and iOS bases. Even if possible, universities can directly invite community representatives to convey the positive and negative sides of implementing WSC community services.

The final stage is sustainable education. Important to note is that education about Water Sensitive Cities should continue after the acceleration and evaluation phase. Sustainable education is vital for strengthening and sustaining positive behavior change over the long term (S. Milligan, 2015; S. Milligan & Kennedy, 2017; Ningrum & Ginting, 2020). Universities on the east coast of Aceh must develop different education programs that engage communities in practical steps to manage water wisely. These efforts include training in water conservation techniques, rainwater recovery, and innovative water treatment systems. This sustainable approach allows communities to continue learning and adapting to new water resource management developments.

The key to a sustainable program is economic benefits for the collaborating parties. Therefore, universities must invite industry and entrepreneurs to participate in water conservation efforts actively. Industry and employers must provide Corporate Social Responsibility (CSR) in the environmental sector. This is an excellent opportunity for the community to take advantage of. However, in several cases, many entrepreneurs are reluctant to provide CSR because managers are not credible and incompetent. Excellent and wise CSR managers are rarely found on the east coast of Aceh. Universities in the region can fill the void in their role as good and wise CSR managers. Furthermore, universities need to design programs that not only absorb CSR fully and on target but also programs that can benefit industry and entrepreneurs. Suppose the industry and entrepreneurs benefit from these programs. In that case, the grand design education towards Water Sensitive Cities on the east coast of Aceh can be achieved.

## 5. CONCLUSION

The discussion in this article has analyzed the problem of the low availability of clean water for communities on the east coast of Aceh. This condition is exacerbated by extreme climate change, which impacts decreasing the supply of clean water in the region. Limited water resources have significant ecological, social, and economic impacts. The eastern coastal region of Aceh faces serious challenges related to the availability of clean water. This area has a lowland topography and is dominated by swamps. These landforms are prone to saltwater intrusion and the risk of flooding. In addition to natural factors, the low quality of clean water management also plays a role in this problem. In other words, the human factor is critical in developing the east coast of Aceh towards Water Sensitive Cities. Therefore, education is identified as an essential component for realizing WSC.

Collaboration between universities, communities, and corporations is the key to the success of structuring the east coast of Aceh as a WSC. The co-design and co-benefit approaches are used in managing water resources, involving the active participation of various stakeholders and aiming to achieve mutual benefits. This approach considers social,

economic, and cultural interests and ecological sustainability. This article formulates three phases in the educational grand design to realize WSC on the east coast of Aceh: acceleration, evaluation, and sustainable education. The accelerated phase increases the intensity of the educational efforts carried out previously. This acceleration effort can be achieved by developing an online learning platform based on community services. Community service activities aim to provide direct experience for students as well as opportunities for them to interact with issues that are relevant to community needs. The evaluation phase is the phase of measuring the success of the acceleration phase. The indicators measured are the monthly users' number, learning activities through community services, and activity outcomes. The third phase is sustainable education. This phase ensures that the educational grand design economically impacts all parties involved. Therefore, companies' involvement is necessary to support this effort's sustainability.

## 6. RECOMMENDATION

Awareness of water conservation is critical to growth within the community, especially if the community wants to implement the concept of Water Sensitive Cities. Communities as subjects as well as objects in water governance have a dominant role in maintaining the availability of a clean water supply. The researcher recommends continuing research on implementing this educational grand design in a comprehensive and in-depth manner. In addition, the government must collaborate with universities and companies to jointly develop technology and policies that support sustainable water management, including applying efficient technology and infrastructure. There are differences in disaster preparedness between high school students in Pangandaran and Garut and between high school students in Pangandaran and Tasikmalaya. However, there was no difference between the preparedness of Senior High School students in Tasikmalaya and Garut. There is no significant difference between students' preparedness in the Garut and Tasikmalaya districts because the two regions are rarely socialized regarding the disaster.

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