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Water stewardship as an aid to water productivity

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Abstract

The Organisation for Economic Co-operation and Development (OECD) have predicted from the years 2000 to 2050 the industrial demand for water will increase by 400 %. This manuscript will discuss water stewardship as an aid to water productivity. The benefits of the integration of water stewardship and water productivity will be portrayed in this paper. The fundamentals of water productivity will be outlined. The stages of water stewardship namely operational, context, strategy and engagement will be introduced. The concept of the green economy and ecolabel products will be discussed. Other synergies including the life cycle analysis, water footprint assessment, multibarrier designs, citizen science and policy development as core needs within the integration will be outlined. The bigger goal of aiding the sustainable development goals (SDGs) to achieve clean water and water security as the main reason for society and corporate business to move in the direction of this integration will be highlighted. Water hydrology and catchment understanding are also the core benefits of the integration of water stewardship with water productivity. Improving water productivity by integrating water stewardship into its practices can improve business practices, environmental water flows, supply chain sourcing, policies, and water-efficient technologies. This manuscript highlights the range of different synergies that can strengthen the integration of water stewardship and water productivity. Water stewardship as an aid to water productivity can place water as a game changer for more eco-economical and environmental practices.

Keywords: Sustainability; Water Productivity; Water Security; Water Stewardship

INTRODUCTION

The Organisation for Economic Co-operation and Development OECD have predicted from 2000 to 2050 the industrial and manufacturing demand for water will increase by 400 % (Stade *et al*., 2020; OECD, 2012). Water productivity (WP) is involved in all aspects of water management taking into consideration water infrastructures such as hydro-energy and drinking water treatment as well as industrial needs. The natural ecosystems water flow productivity is also an important aspect. Water productivity (WP) can be described as the net return for a unit of water used. Water productivity aims to conserve water and make water more readily available for domestic, industrial and natural habitat use. The benefits of encouraging high levels of water productivity include, more sustainable food and industrial product production, enhancement of water security, higher quality clean water and a better appreciation of water and its ecological services (Grizzetti *et al*., 2016). Water productivity can also give rise to the higher levels of better health and wellbeing. Global water security is a growing concern and is also a very important variable which can be embedded within ethical

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considerations surrounding the water productivity and water stewardship integration (Dolan *et al*., 2021). There is a considerable scope for improving the water productivity related to domestic, industrial, agricultural and natural habitat water applications. Such improvements can be achieved through the integration of water stewardship with the water productivity protocol. Such an integration can move society in the direction of more advancement in the following areas of source water conservation and preservation, water harvesting initiatives and the areas such as precision irrigation techniques of soils. Life cycle assessment and management has also a central role to play within the integration. The multibarrier approach is also embedded in the integration. Initiatives such as water stewardship can enhance water productivity by adding the structured protocols which can aid in the auditing of the water productivity performance (Richter, 2009; Holm and Magombo 2021). The auditing can involve the examination for conformities and nonconformities, an example in relation in relation to the European water certification programme can demonstrate the auditing process (EWP, 2017).

WATER CONCERNS EVERYONE IN SOCIETY

Water is a global concern and it needed for the sustainability of life. Projected water demands suggest businesses need to be more economical and conservative in their water use (Boretti and Rosa, 2019). As this paper which is focusing on water productivity and water stewardship it is important to introduce the International water stewardship standard (WWF, 2014). The Alliance for water stewardship standard, also known as the International water stewardship standard (AWS) standard can be applied globally. According to the definition by ceowatermandate, 'water stewardship is a framework and set of practices that help businesses manage risks, curt costs and build trust while promoting long term water security for all' (CEO, 2021). The aim of the water stewardship standard is to create awareness of water use and the impacts of excessive use. Another aim is to move in the direction of sustainable water management practices. The standard endearers to embed the three pillars of sustainability namely environmental social and economical within water practices. The importance of water stewardship as an aid to water productivity is due to the fact the water stewardship forensically examines the wider catchment as a whole from source to tap while implementing the standard. In comparison the water productivity concept solely looks at the water use within the boundary of the company's inputs and outputs and does not examine the large catchment water ecosystems.

The integration of both water productivity and water stewardship can influence the following:

a) Developing countries with little water resource development can benefit from small changes in water conservation, small changes can make a large impact.
b) Areas globally having water scarcity problems due to the effects of droughts and flooding can benefit again by water conservation and pollution control awareness and management.
c) Areas of ecosystem degradation such as lowered baselines groundwater tables, and river desiccation due to excessive non-sustainable practices can be monitored as part of water stewardship.
d) Product developers, industry and water service providers utilising land, marine, fresh, and brackish waters are challenging the sustainability of their water practices, and are beginning to implement water stewardship into their strategy policy documents.

e) Water security and wars about water are a concern for future generations which can be addressed partially by utilising the integration of water stewardship and water productivity.
f) Challenges of water treatment and related costs can also benefit.

The integration of water productivity and water stewardship can also portray the importance of examining both geophysical and socioeconomical factors in their implementation (Whiteford, 2018). The precautionary principles related to water security and sustainability are also nurtured within the integration.

WATER PRODUCTIVITY

Water is precious and globally the earth is known as the blue planet (Skinner *et al*., 1999). Water productivity, measures what can be produced from a unit of water which is generally measured in m^3 (Molden *et al*., 2010). The measurement can be based on the Water Productivity Index WPI, which is the ratio between a unit of output (in physical or monetary terms) and the unit of input of water in volume terms (European Commission, 2021). The International Water Management Institute (IWMI, 2021) defines the water productivity concept as follows; The reason the concept of water productivity was introduced by governments and governance was to provide a tool for policy makers to develop criteria for the protection and sustainable of water resources and water ecosystems (Marston *et al*., 2020; Vladimirova *et al*., 2018). Differences found in the WPI between countries might be attributed to a variety of factors, such as the structure of the economy, the variations in applied technologies for water use and treatment. Other differences in the WPI can relate to present the management practices, the availability of water resources and climatic conditions which cannot be modified by policy measures in the short term. The Water Productivity Index, WPI can provide an overview of the water productivity of a country and can be used to monitor trends over time. Trend analysis can help improve performance. In Europe the Water Productivity Index WPI is computed by Eurostat based on data provided by Member States (European Commission, 2021). The coordinators for collection and computation of the water data vary between countries and between sectors. It is difficult to compare the water protectivity between countries due to variance in for example the human development index and the countries climates (UNDP, 2021). More importantly within a country trends can be noticed and hopefully positive trend strategies can be explored.

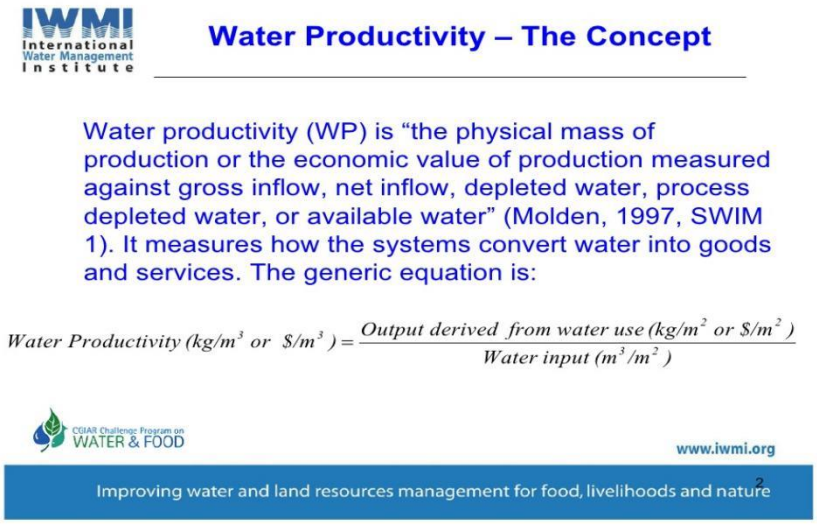

Fig. 1. Water productivity the concept (IWMI, 2021)

Factors influencing water productivity include both manageable and non-manageable factors. An example of manageable factors includes for example introducing infrastructure upgrades such as piping to minimise water loss. Other manageable factors include legalisation introduction, water pricing policy and introducing management practices related to the water quality. Non-manageable factors that can affect water productivity can include climate and the microclimate, specific crop water needs, natural characteristics of an area, water quality baseline characteristics, and water availability.

As stated earlier countries globally have influencing factors unique to the individual countries so it is difficult to compare the countries values of water productivity index. Proper management of water from source to tap or use be it agricultural or manufacturing is crucial to good performance of water productivity and water stewardship practices. An important variable to aid water productivity is to implement water stewardship and measure the performance in terms of key Performance Indicators (KPI). Water productivity can then be correlated as part of the Key Performance Indicators (KPI). Correlation in terms of how the water stewardship standard it implemented is also important.

THE IMPORTANCE OF WATER STEWARDSHIP

Water stewardship is important to nurture due to its links with the human population expansion and related human carrying capacity and the water footprint (World Population History, 2021; WFN, 2021). Other important variables highlight its importance including climate change, economic growth and the sustainable development goals SDGs. The Sustainable development goals relevant to water presses the need for global initiatives for the development of water stewardship (UN, 2015).

The selling perks to the introduction and implementation of water stewardship to a company or ecological catchment integrated with water productivity include, managing water better, mitigation of water-related risks at the water operations level. The introduction can also enhance the understanding of the full Life Cycle Analysis (LCA) of water from source to tap and where feasible the implementation of recycling strategies. Quantifying the volumes of water use and waste water produced is embedded within the Life Cycle Analysis linked also with the water stewardship protocol. Understanding the impacts on the ecological services of water is also core to the water stewardship implementation (Grizzetti *et al*., 2016).

HOW WATER STEWARDSHIP IS IMPLEMENTED

The water stewardship concept strives to utilize water in a socially, equitable environmentally sustainable and economically beneficial way (Irish Water, 2015; ISEAL Alliance, 2015). Key Performance Indicators to be addressed when implementing the standard include;

- Understanding water dependencies and impacts related to the three pillars of sustainability.
- Mitigation of operational and supply chain water risks how water practices can be improved.
- Ensuring responsible water practices are utilised when using, treating and recycling the water.
- Building relationships with local water-related stakeholders including citizen scientists.
- Addressing challenges of water sustainable practices shared with stakeholders including citizen within a catchment.

The performance of the water stewardship initiatives in based on a number of tasks, gathering information, designing and planning and commitment to improvement. Evaluation of the plan and

maintaining the standard are also important tasks. The maintenance of the plan is dynamic and is continuously improving and innovating. Innovations can apply to good water governance, sustainable water balance, water quality, sustainable ecological services of water and safe clean water and sanitation.

The stages of implementation water stewardship incorporate water productivity but also can have the bigger goal of developing a popular culture of giving clean water security to all.

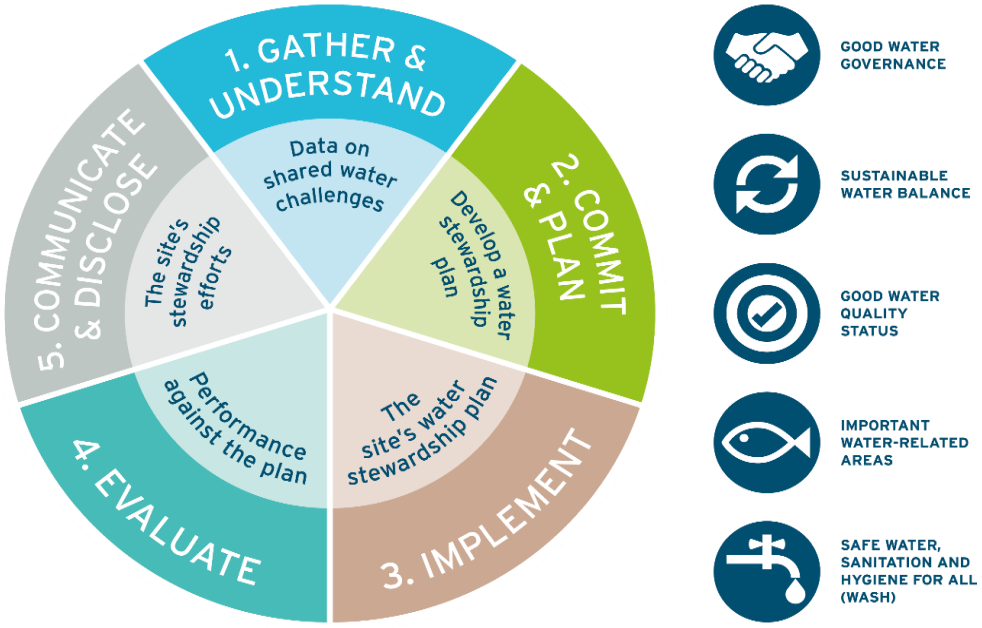

Fig. 2. Tasks related to the Key Performance Indicators of water stewardship (CEO, 2021)

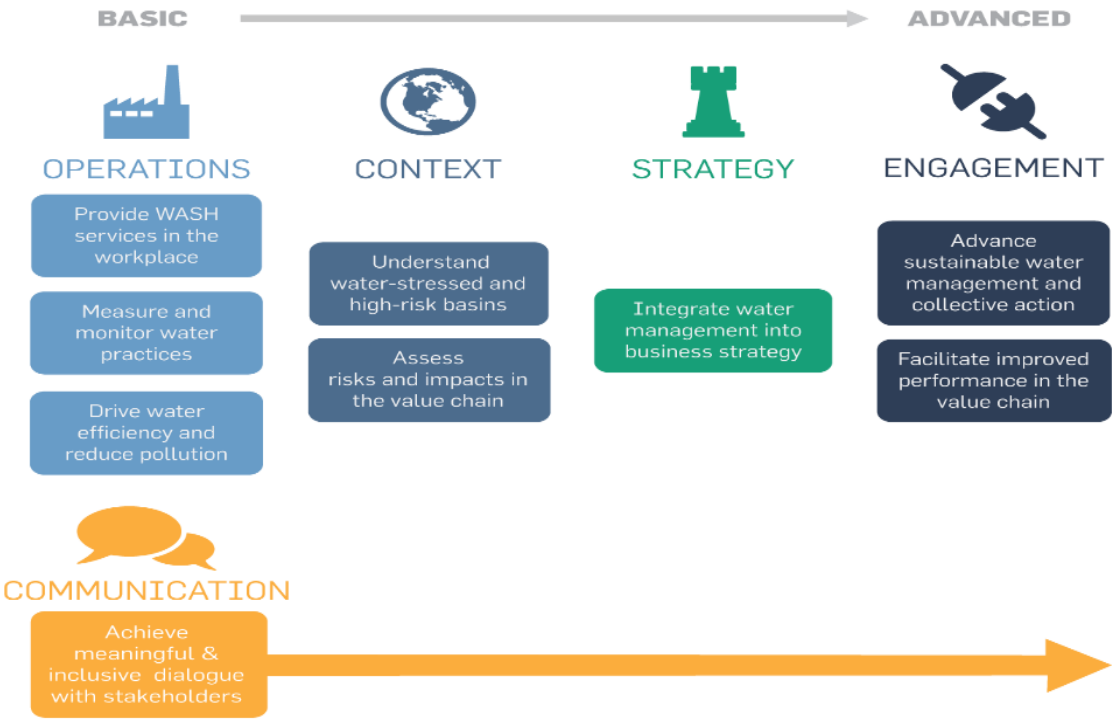

Fig. 3. Stages of implementation of water stewardship (UN, 2021)

The first stage of implementing the water stewardship protocol would involve understanding the operations in terms of what the water is being used for. The operations also involve measuring and monitoring the inputs and outputs related to water and optimising the process in terms of minimising water volumes used. The first stage would also entail preventative measures to minimise pollution from water. Pollution measurement and monitoring is also important. The first stage emphasis also the basic needs and right to clean water and proper sanitation practices. Assurance to all workers within the organisation of high hygiene practices in terms of water availability is also documented in the operational assessment stage.

The context stage goes beyond the water operations within the company and also looks at the catchment waters. This stage also examines the impacts and risks of the catchment in terms of the source water and the receiving waters in the case of the discharges from the operations. What are the challenges on the hydrology of the catchment by the operational activity of the company is embedded in the context stage.

The strategy and mission statement of the company business having an aim to nurture water sustainability is the next level up in terms of water stewardship (Asset Management Taskforce, 2020). Engagement with stake holders and initiating a culture in society of good water practices in terms of sustainability is part of advanced stewardship practices.

The advancement of water stewardship post 2015 are based on reflections on performance. Partnership involvement, communication, business strategy, hygiene and sustainable production are very important as advancements with the initiative.

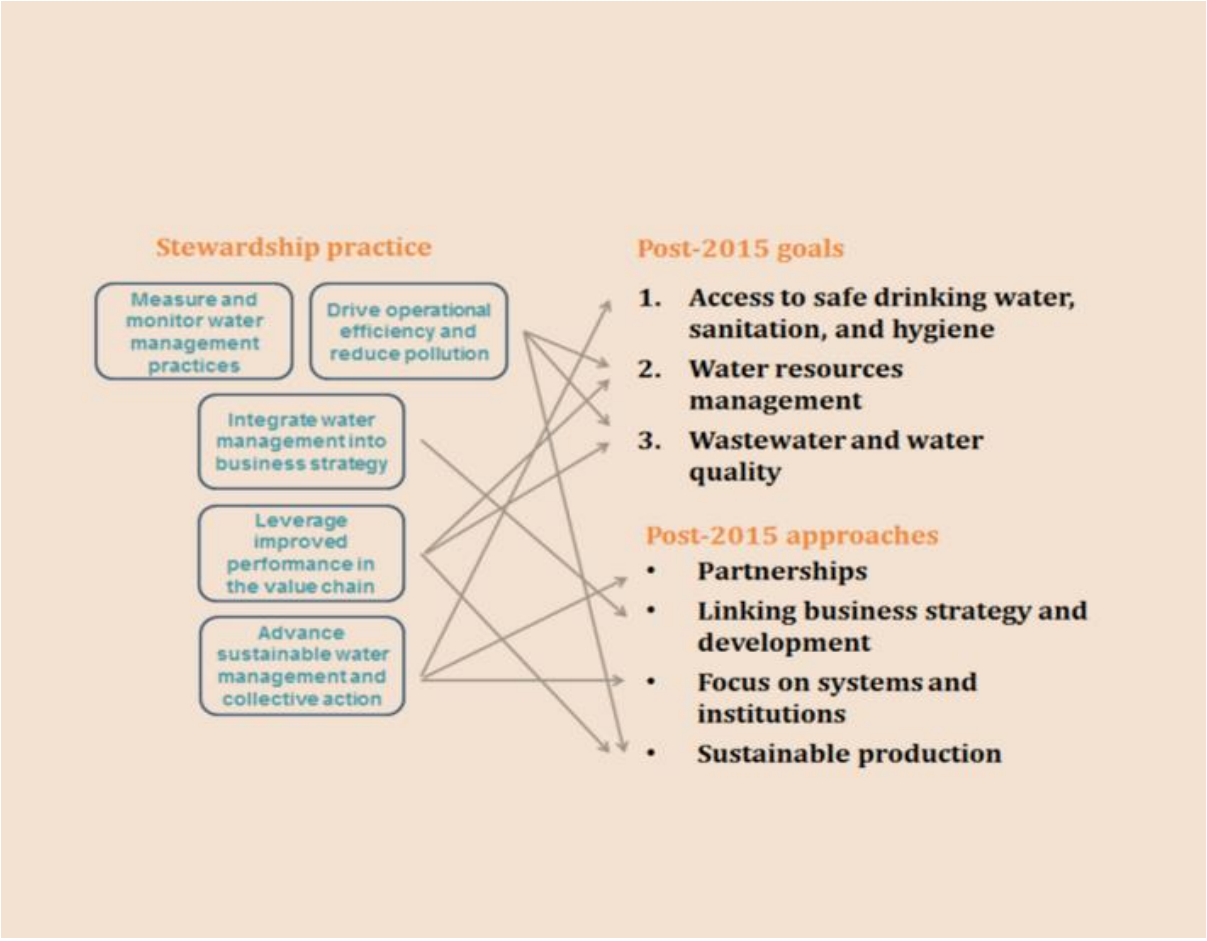

Fig. 4. Advances and evolution surrounding water stewardship (UN Global Compact, 2021)

OTHER CONCEPTS LINKING WITH WATER STEWARDSHIP

A range of concepts linking with water stewardship will now be discussed. Life Cycle Analysis and sustainable production are majorly aligned with water stewardship. The multibarrier approach understanding source to tap strategies is also an important concept.

LIFE CYCLE ANALYSIS

The Life Cycle Analysis LCA can often be expressed as the cradle-to-grave approach. Water LCA is often not placed as high importance when developing a product in terms of the overall Life Cycle Analysis. The concept of water stewardship has corrected the gap in knowledge surrounding the inclusion of water within the LCA analysis of a product (Cashman *et al*., 2016; Godskeen *et al*., 2013). The water LCA starts with a scoping study followed by an inventory analysis and then an impact analysis. The water footprint can be deployed as part of the water life cycle analysis LCA (De Boer *et al*., 2013). Life Cycle Analysis helps understand the global impact of fresh water use (Canals *et al*., 2009; Kounina *et al*., 2013). The LCA helps create an understanding from the inventory analysis of the importance of water conservation. An interesting study of water conservation initiatives for industry can be seen in the literature (Yari *et al*., 2020).

SOURCE TO TAP EFFICIENCY MULTIBARRIER APPROACH

The multibarrier approach enhances the understanding of where the water comes from, its treatment and uses and the stresses in between. The quality of the source effected by point and diffuse pollution issues and improvements in quality in also part of the multibarrier approach (EEC, 2020). Site and catchment-based actions are important in terms of the multibarrier approach.

Fig. 5. The multibarrier approach traditionally used for drinking water treatment (Water NSW, 2021)

The multibarrier approach is readily used for drinking water treatment plants but can be expanded to benefit the broader water stewardship applications.

NATURAL AND MANMADE ECOSYSTEMS AND PERMACULTURE

Permaculture initiatives and water productivity and water stewardship are also important to develop (IWA, 2021; WWF, 2017). Protecting of the source water supply can be enhanced by permaculture initiatives. Permaculture designers believe that through intelligent landscape design linking the elements and functions water quality and climate change impacts can be improved (Whiteford, 2018). Permaculture initiatives can counteract Anthropocene problems in habitats (De Mello and de Paula, 2019).

CLIMATE CHANGE AND WATER SECURITY

Climate change has caused a rise in water risks around the world the major risks are due to droughts and floods. These risks can affect water security and water quality thus effecting for example the abstraction sources of water. An interesting article discusses the strategies to improve water productivity inline with the fact that climate change increases variability of the water cycle and thus reduces water availability (Sivakumar, 2021). Businesses are increasingly obligated to demonstrate the commitment to addressing the global water crisis linking with the sustainable development goals and water security (CDP, 2016). To modernise their business in a sustainable green way corporate businesses need to identify and quantify the water risks, develop robust water strategies and action plans, and better understand the costs and opportunities of effective water management. Again, water stewardship as an aid to water productivity can help guide this process.

THE SUSTAINABLE DEVELOPMENT GOALS

Water stewardship enable aids for the implementation of the sustainable development goals in terms of water security and the right to clean water. Small initiatives can made large impacts such as water sustainability linked with water conservation (IUCN, 2000). Accountability of water practices by industry are so important to aid the sustainable development goals (UN, 2021). Clean water giving rise to more water availability could be a fundamental sub goal of the sustainable development goals.

POLICY DRIVERS

Policy drivers for example the European Union water framework directive and auxiliary directives such as the habitat directive will gain from the integration of water productivity with water stewardship (Europa. eu, 2021; Özerol *et al*., 2018). Strategies to improve the water productivity should simultaneously consider implementing policies to improve water management (Sivakumar, 2021). Water risk reductions can move businesses to implement the water stewardship which can aid policy development.

The integration will also give rise to less pressure on water treatment plants due to less water use. Climate change policies can also benefit. As can be demonstrated below the macrosphere and microsphere level of influence linking with water productivity and water stewardship and water sustainability shows the importance of transparency, improvement and engagement due to large communication between the microsphere and the microsphere.

The macrosphere is the governance and the microsphere is how it is enacted. By learning and engaging and being more transparent with the microsphere policy can be improved and developed by the bottom-up approach.

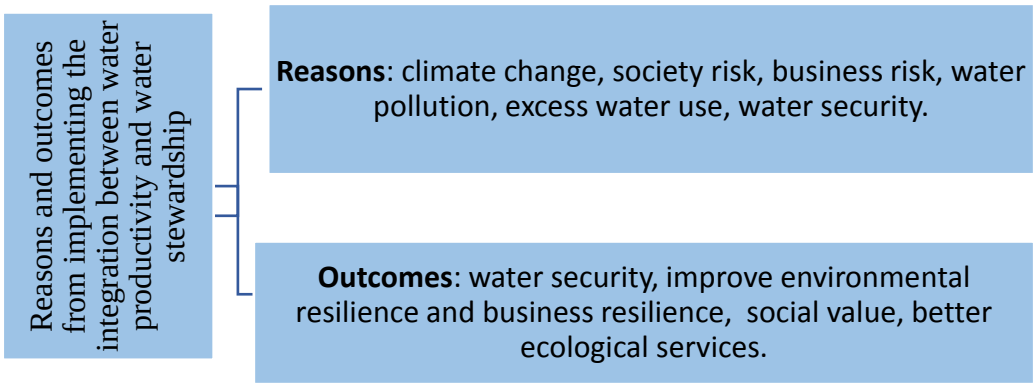

Fig. 6. The Reasons and the Outcomes surrounding the integration between water productivity and water stewardship

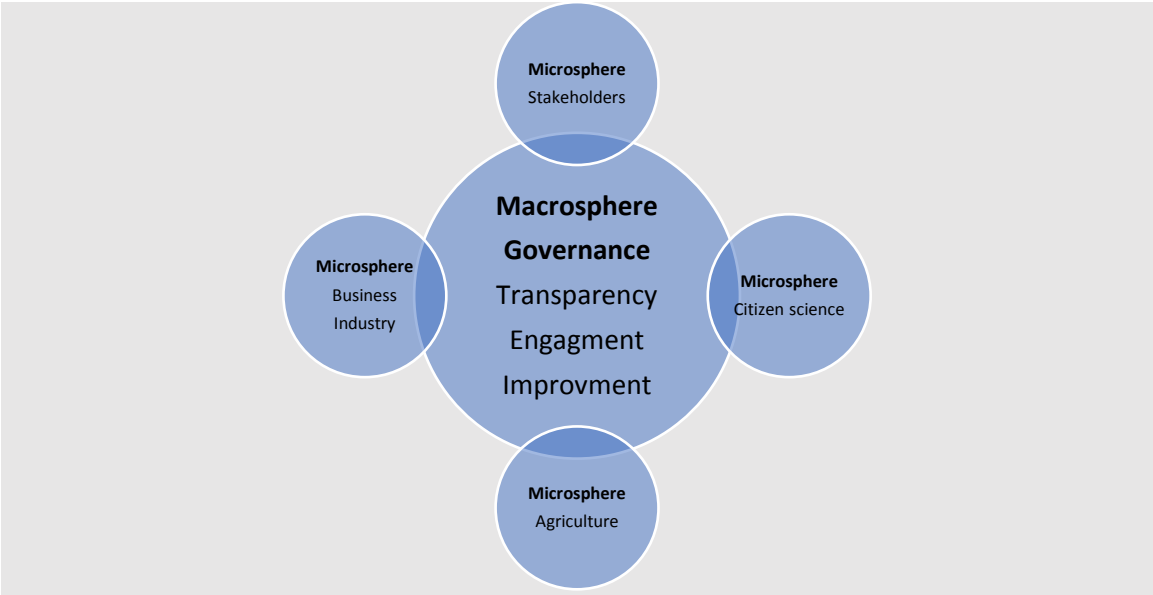

Fig. 7. Spheres of influence from the Macrosphere to Microsphere

CIRCULAR ECONOMY

The Circular Economy with a focus on water examines approaches to make a product or activity with less water (IWA, 2016). It designs the processes to avoid excessive water use, have efficient water use and potentially where possible recycle water and where possible remove previous components from the discharge water (Willet *et al*., 2019). The processes of harvesting water and continuous improvements through better water resource allocation and management are all of the parts of the water circular economy. Reuse of water within an operation can be considered a closed loop application. When recycling occurs, it can be used for internal operations or can be used for the outside activities such as cleaning transport vehicles or recharging water ecosystems. Recycling waste streams in areas such a controlled heat and power 'CHP' which involves taking the heat energy from water and recycling the heat before the water is discharged is an innovation surrounding the circular economy (Breeze, 2018). The circular economy can be considered a less linear way to the management water (UNESCO, 2020).

Until recently the topic of the 'circular economy' focuses on raw materials, solid waste and solid waste recycling. Less

talked about is water recycling and energy recycling from water, fortunately this gap in knowledge surrounding the circular economy is beginning to change (Microgrid, 2021).

E-COMMERCE AND WATER STEWARDSHIP

The E-commerce approach incorporates the Eco green label and process intensification into product design or services (European Commission, 2015; GEN, 2013). The Eco label can make the product more attractive to customers by documenting on the label the water usage, discharge and recycled waters within the product design (Zhang *et al*., 2019). Water stewardship linked with water productivity bring a great green awareness confidence in the product.

CITIZEN SCIENCE

Citizen science and the involvement of stakeholder are important to nurture for the larger scoping study surrounding water stewardship. Enhanced involvement of citizen science can cause a ripple effect to communities' awareness and education surrounding water conservation, water productivity and water stewardship. Citizen science and the ripple effect can help policy implementation (Mc Kinley *et al*., 2017; Sarni, 2013).

RESULTS AND DISCUSSION

Innovations surrounding sustainable services and manufacturing are very important to nurture in society (Jones *et al*., 2017; UNESCO, 2021). The importance of water stewardship and water productivity is so important more than ever now in the year 2021 due to climate change. The 2020 UN world water development report (WWDR, 2021) title 'water and climate' highlights the importance of the water community to tackle the challenges of climate change and educate themselves about the opportunities that improved water management offers in terms of adaptation and mitigation. A quote from the English Historian Thomas Fuller from 17th century which states, 'We never know the worth of water till the well is dry', shows the importance of water down through the centuries (Fuller, 1732). Water stewardship can be considered a form of leadership. Companies that implement water stewardship can be considered environmental management systems facilitators. The ripple effect can occur as great stewardship practices will influence the microsphere and macrosphere by highlighting the needs to sustain and secure our water resources and aqueous ecosystems. The popular culture of an organisation in terms of water productivity and integration of water stewardship can give rise on a ripple effect within society through community involvement (Sengupta, 2017). This ripple effect from the organisation to citizen science including awareness surrounding water sustainability can enhance the rights of everyone to clean water and basic water needs. All stakeholders including community involvement can improve the water sustainability agenda. Modern challenges globally such as Covid 19 highlights the importance of security of every country for clean water due to its basic needs for hand washing as a mitigation and preventative of the covid 19 virus (UNICEF, 2020; UN, 2019; United Nation, 2016; SIWI, 2020). The importance of the integration between water productivity and water stewardship goes to the core of the right of everyone to clean water and the challenges of obtaining clean water in certain parts of the globe (Treacy, 2019; Rodell *et al*., 2018). Society and business need to respect the importance of water and can no longer use water with a business as usual attitude (Hui-Cheng *at al*., 2020). Society must change the popular discourse to sustainability of water use in industry and for the development and manufacture of a product (Hui-Cheng *et al*., 2020; Rozza *et al*., 2013). In society, there is a large emphasis on the carbon footprint but the

water footprint needs to be given a stronger emphasis in the strategy norms of organisations and the corporate world. Proper implementation is important in relation to the integration of water productivity with water stewardship. Proper implementation and review and auditing utilising a dynamic approach for constant improvement is salient. The permaculture principle of sharing resources has benefits for all society and must be encouraged. Ethical water use within an organisation must be part of the culture and strategy of an organisation. Water Stewardship as an aid to water productivity will minimise the global water risk for industry and society (Barton, 2010; Daniel and Sojamo, 2012). Environmental management practices will be enhanced with the integration of water stewardship with water productivity.

CONCLUSION

This manuscript highlights knowledge of the different synergies such as the multibarrier approach that will strengthen the relationship between water stewardship and water productivity. Business resilience is as important as environmental resilience when it comes to water management this is a major reason for the promotion of water productivity integration with water stewardship. The benefits of the integration between water stewardship and water productivity creates real meaning in terms of water sustainability and water available for all of the society globally.

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