Assessment Of Water Foot Print For Sustainable Use Of Water In University Of Gujrat, Pakistan

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Research Article

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Abstract

Water Footprint Assessment is used as a method to evaluate water consumption pressure at present and its possible future demands. It is a measure of direct and indirect water use by an individual, an activity or a process. For humans its measure changes with changing life ages, stages and styles. For activities its measure varies with materials, products and processes. At campus level most of the life forms and majority of life activities are together available. Specifically in UOG people from different cultural backgrounds are present at the same site. Academic, research, lab, library, stationery, cafeteria and transport services are actively working in the campus. A social survey was conducted at campus. Person to person water consumption is directed through questionnaire and structured interviews and for products & services data is gathered through data sheets. A statistical analysis is conducted to find individual measures of water consumption per day, per month and per year in the campus. Guidelines for sustainable water use are developed by considering the consumption patterns and life styles analyzed by data from different societies in the campus. This is how without compromising our present water demands we can make it possible to meet our future needs and needs of deprived ones as well. This is simply possible by changing our ways of consumption and a slight shift of balance in our eating, seeming and treating habits.

Introduction

Water is a dire need of all life forms. Hence water scarcity is a rising and burning issue considered all over the world (Mekonnen & Hoekstra, 2016; Liu et al., 2014). Developing world is more critically facing this dilemma (Zyoud et al., 2016). Pakistan is categorized as highly stressed country and situation is getting worse day by day (Khoso et al., 2015). Water availability to the intended use and consumption patterns needs to be balanced. Water footprint assessment (WFA) as a baseline data collection and future recommendation is highly necessary.

Water footprint (WF) is the measure of water utilized or consumed either directly or indirectly by an entity such as a person, population, community or nation. In fact, water is essential part of almost everything either it is naturally gained or is an anthropogenic one. Like: Food, clothing, electricity, transport, paper, etc. Fresh water from rivers, lakes and aquifers is consumed. It is either contaminated in manufacturing process or is captured in a product. On average, the amount of water required and approached for the existence of an individual is considered as WFs. Its measure alters with the changing life style. These initial perceptions of WF are from same source (Aldaya et al., 2012).

> “*The water footprint is a measure of humanity’s appropriation of fresh water in volumes of water consumed and/or polluted.*”
>
> (WFN, 2008)

Water footprint is an indicator for efficient and sustainable water use and water management (WFN, 2008). The concept WF is created in 2002 by Hoekstra, who is Professor in Water Management at University of Twente, Enschede Netherlands. He is also the founder of Water footprint network (WFN) (UOT, 2018). Water footprint simply defines the measured amount of water burdened as a whole caused by a person, a community, a manufacturing unit, farming products, activities of a business or project and a geographical locality. Its measures changes with ages and stages of life, steps of processes and activities of an area.

As water is important for every activity of life but fresh water is a limited natural resource. So an assessment and calculation of water use or water loss is quite essential to understand our future demands and burden on available resources. Water footprint is calculated in liters or cubic meter (m^3). Different levels of WF are as: Blue water footprint (BWF), Green water footprint (BWF) and Grey water footprint (GYWF). Blue water footprint is amount of water vaporized or directly consumed from surface and ground water. Green water footprint is quantity of water vaporized or directly consumed from rain water. Grey water footprint is amount of water required to dilute and maintain water quality in pollutants (WFN, 2008).

Water supply and use at a certain time and location is considered in expression of WF. Water footprint assessment is an indicator of water management in terms of water use. It refers; to quantify water consumed or polluted for a specified consumer at a definite time and space by assessing social, environmental and economic sustainability as well as planning response strategy (Hoekstra et al., 2011).

Hoekstra describes WFA as an innovative approach for water management. He expresses it in four distinct dimensions as follows: 1) focusing on indirect water use; 2) analyzing the purpose behind consumption; 3) targeting the greater consumer of water; and 4) examining the pollution load and future development (Hoekstra, 2017). Now, WFA is considered as a water management scheme involving its four folds: purpose of consumption, accounting for expenditure, sustainability assessment and response formulation (WFN, 2008). Water footprint assessment provides way to use water, understand pollution and measure scarcity. It also presents ideas and means to acknowledge water related issues and water sustainable use in every sector. It helps to consider impacts of direct and indirect water use, in water management (Hoekstra, 2017).

To overcome long term water scarcity, water supply and consumption have to be managed as an integral part of water resource management. This effort can be more conveniently started from institutional setups because educated people more likely accept, understand and apply new policies, plans and strategies.

In Pakistan, water sustainability is most crucial to determine in various sectors. Water footprint assessment methodology is adopted to introduce water sustainability through international standards in the institutional setup. It comprises three trends as: consumption, conservation and reuse.

University of Gujrat (UOG) is a remarkable site because of its location and diversified ecological and cultural zones. People including learners and employees from vicinity and different districts like Gujranwala, Sialkot and Jahlum are engaged to stay in the university premises from 8:15a.m to 4:15p.m. Consumption, supply and demand of water are accordingly happening for individuals, lab works and cafeteria services. A residential area for different staff members is also situated there. Water footprint assessment to approach sustainable use of water, in terms of water conservation and reusing at Hafiz Hayat campus in UOG is mainly targeted in this research work.

In WFA findings, sustainability assessment is connecting whether water consumption is balancing with the nature and human demand or not. How the limited water resources are being available to the greatest benefits of humanity and how fairly we are sharing this natural resource (WFN, 2008; Aldaya et al., 2012).

Sustainable use of water is a disciplined way of water use and preventing water loss. It connects people to use such products and services that need less amount of water in their production. For instance the required amounts of water for different activities of manufacturing are as follows: refining 1 kg of sugar (1500 L), 1 kg of tomatoes (180L), 1 meat burger (2400L), 1 cup of coffee (140L), 1 kg of leather (16,600L) and 1 A4 paper sheet (10L) (Hoekstra, 2009). This assessment of WF of each product helps for taking necessity for reducing our personal WF. By preferring one product made with low water footprint (LWF) over other with high water footprint (HWF), while both products can provide same benefit.

An inventive driver for resource management sustainability is corporate social responsibility (CSR) which links more sustainable supply, assembly and utilization patterns (IMACE, 2016). Guidelines associated with sustainable water use involves: conservation steps like water saving taps and toilets, using buckets instead of a hose, putting bucket in the shower or showerhead replacing direct showers, get low-flow toilets and faucets, prevent leaks, using washing machine when it is full. Reuse options such as rainwater collection for gardening etc. (GCF, 2018). All these long term and short term measures are necessary to prevent water stress.

In this research work, an assessment and analysis of WF at our campus is planned. The studies proposed by Hoekstra will be consulted as most helping source. The applicable time period is 2018–2019. This initial step towards water assessment and management in Pakistan provides a way out to defeat water challenges. Its extension in future research projects concerning water conservation and management policy will surely position it as a milestone.

Significance Of Research Work

One of the biggest problems of mismanagement is to frequently pollute surface and ground waters. Universities are considered the hub of learners and researchers of a country. To introduce a new trend by eliminating a traditional way in thoughts, moods and behaviors is appealing in this system. Approaching a sustainable water consumption pattern introducing it to the institutional level could be a successful step.

Water preservation is an essential need of society, economy and environment in Pakistan. A large amount of water is consumed by human use like washing, flushing and bathing etc. How much water is needed for a person, per day is not still estimated in Pakistan. There is a lack of management practices for meeting the requirements of future generations. How much water is available from fresh sources and how frequently it is being converted into waste streams on daily basis is still unexplored. In the current scenario, this is because of lack of awareness and carelessness. It could be a practical step to evaluate our needs, availability and consumption. An approach towards water sustainable use can prevent from future water crisis.

Review Of Literature

Burman et al. (2018) reported a review in which they have demonstrated studies related to life cycle assessment (LCA), carbon footprint (CF) and WF for the period of 2001–2015. It was described that 70% research work has been conducted related to food, forestry, paper, energy and waste management. But less work has been carried out for textile, footwear and mineral industries that could be explored in future.

A lot of research work is carried out for water assessment and sustainable use. It mainly focuses water management issues on the local scale by developing suitable government policies. In the most recent analytical efforts and with the development of WF concept research scenario has changed. Water footprint assessment is carried out for various regional (local and national) developments. It specifically emphasizes the business community for water consumption and resource pressure. Calculating their pollution loads in terms of water exploitation. Most of these works are case studies for some specific river catchments, a production unit or a geographical territory.

Water Footprint Assessment Reviews

Water footprint is an innovative concept (Aldaya et al., 2011). This idea is parallel to the CF and ecological footprint (EF). The amount of water (m^3/ton) directly, indirectly and virtually consumed by individuals, communities was formulated for assessment. Water footprint was also calculated for a certain product, business and geographical boundary. In this manual, the setting of global standards and its goals for WFA are provided. It tells what is need to be measured and why, in human appropriation for fresh water. It stepped the process of assessing WFs into BWF, GWF and GYWF. Calculation of these WF categories for growing a tree or crop, WF of a consumer, or group of consumers, WF with a geographically delineated area and national WF accounting, were illustrated. Four distinct phases in WFA were given. Blue water footprint accounting for recycling and reuse was described. In this book irrigation process was demonstrated having different WF count for storing of water, transport of water and water for irrigation in the field etc. Virtual water was not completely or according to the strict definition practically existed but rather it was suggested although directly unexpressed. In WF accounting spatiotemporal explication was given. Spatial explication for global and temporal explication is for a year. It also covered options for farmers to reduce their crop WF and for government to reduce WFs to mitigate their impacts. It also described how WFA could help in LCA.

Hoekstra (2017) revealed the idea of WF in expressions of human use. The most frequent relation of water and human use was direct use of water for personal needs such as drinking, bathing and washing. Indirect use of water was using the various products and services that have taken water for their manufacturing. He gave commercial use of water more importantly in water related issues as the huge amount of water was consumed in trade. He also provided the idea to the governments to solve local water management issues by understanding a broader canvas dealing consumer, investors and companies. He focused on considering water pollution and scarcity along with the role of water in advancement. He related the pillars of sustainability economy, society and environment with WFA.

Zeng et al. (2012) studied the WF at Heith river basin (HRB) in China. In this study they examined and defined the importance of WF calculations in the quantification of water insufficiency at each stage. They emphasized the role of water and its resulting pollution from human actions. Here, they considered two levels of WF (green and blue) with reference to agriculture, livestock and industrial demands. However, they have not included GYWF estimation of HRB due to insufficient data on pollution load of this river basin. Santosh et al. (2018) presented a similar study on Gomti river basin (GRB) of India by assessing its WF. It covers BWF, GWF and GYWF of GRB. It gave a comparison of WF and virtual water. Agriculture is the biggest WF consumer. Blue water footprint high rate indicated irrigation dependency.

Hoekstra and Chapagain (2007) explained that water consumption by public and as a whole nation and its impact. It varied with the life style and activities in which different persons were involved. The water directly consumed by a nation was termed as internal water. Water utilized by the nation in form of trade in manufactured goods and services from other countries was termed as external water. In this study, a general idea for a nation's WF calculation at a certain time phase was presented. Then, a comparison of WF calculation for different nations was given along with average global WF calculations. Here activity of whole nation was divided into four discrete elements apropos to water consumption like food, agriculture, economy and development.

Fereres at el. (2017) illustrated the water role in a product formation. Naturally it is cropped then it was passed through the various stages of transportation, preservation and mixing etc. to be accessed to the individual who has to consume it. Each phase involved water consumption in different amounts and patterns. They gave the difference between CF & WF. As carbon emitted once in the atmosphere was added to the globally atmosphere while evaporated water was influencing locally.

Boulay (2017) in their multidimensional study on WF, scarcity and water use life cycle assessment (WULCA), formalized impact evaluation of ISO standard 14046. Water availability and deprivation was studied for all life forms at certain place and time.

Sustainable Use Of Water Guidelines

Cecilio and Zanelti (2018) reported the study of WF and sustainable use of water. The study areas were a watershed linked to the forestry, agronomy and urban and rural sanitation. The total WF was calculated.

Green water footprint was estimated at the highest level. It was resulted unsustainable condition that leads to scarcity.

Hoekstra et al. (2011) suggested the history of WF sustainability assessment. In fourth chapter i.e. sustainability of WF of a process, a product and a consumer was described.

Hoekstra (2015) illustrated in his research for water consumption in relation with public utility. He gave the idea of trade water. Water embedded in a product transported to some other place was considered in expressions of virtual water footprint (VWF). The water consumed has its impact on its resource, although it will be utilized at some place of its trade. Water pollution of an area and its reduction to sustainable level was measured in WF. It helps to explore new ways and means to make effective policies by government institutes related to water management.

Hoekstra and Mekonnen (2016) study introduced a technique to evaluate sustainability of external water foot (EWF) of a nation. In this case study, EWF of UK was worked out. Blue water footprint appeared to exceed sustainability limits. This unsustainable level of BWF of UK was concerning from different countries like India, Pakistan, Iran, USA, Spain and South Africa. About half of UK's agricultural water was beyond sustainability range. They further told by reducing this WF to a certain level of sustainability which might be achieved. In this regard they have presented few suggestions. Such as local food dependency that trying to increase water efficiency in water stressed regions and international association for achieving global water sustainability.

Another study conducted by Hoekstra (2018) who expressed way out to reduce our WF. First he pointed out the exploitation of fresh water throughout the globe. Secondly he mentioned its consequences such as depletion of aquifers, collapse of groundwater table, disappearance of streams and river water pollution via pesticides. In UK, public water footprint (PWF) up to 50% is related to global basins that are beyond the sustainability edge. Hoekstra presented three applications to attain the goal of sustainable water use, which are as follows:

a) By introducing water footprint caps on each river catchment over the globe to limit water consumption. Water footprint cap also uses to define pollution level depending on assimilation capacity of river.

b) Allowing limited WF permits to the users. To regulate the water used and pollution entered not to surpass sustainable level.

c) By establishing water footprint benchmarks for public, fresh water use and pollution loads could be controlled. From this study LWF can be achieved by making and buying cleaner products that are sustainably originated. By stabilizing the LWF of all consumers throughout the world to manage water needs of the expected population.

Bonamente et al. (2017) described the water use of a nation scoping its economic dependency. They considered water sustainability level by its utility and availability ratio. Water footprint is an indicator of water measurement which was used to evaluate scarcity. Geographical Information system (GIS)

applications were involved for mapping; land cover, pollution load, and economic circle. A statistical overview was generated for water use sustainability understanding.

Pellicer-Martínez and Martinez-Paz (2016) identified water sustainability which was a principal challenge of today. In this study, WFA methodology was adopted to achieve resource sustainability of a river basin. This study described how water managing policies influenced its sustainability.

Most of these research works is carried out in Europe. These provide a scheme of study and analysis for water management process and futuristic approach. A similar study and analytical research is a dire need of water scarcity areas. A geospatial WFA was practiced in Lahore, Pakistan (WWF, 2017). Water footprint based on social survey, concerning the assessments and calculations carried out to acknowledge current atmosphere, awareness level and future policies is planned in this study. In fact, this research endeavor will be a forward step to handle water crisis.

Work Place

In this research work selected study area for WFA is a geographical territory: “Hafiz Hayat Campus of University of Gujrat (UOG), Gujrat, Pakistan”.

Work Plan

1. Baseline data collection for water consumption (use & loss), from various societies especially: academic regime, cafeterias and residential areas at the campus.
2. Water footprint assessment via social survey, based on International WFN which provided WF calculator and methodology.
3. Social survey of campus communities via questionnaire and face to face questionnaire.
4. Water consumption analysis and calculation in terms of WF at campus based on social survey quantitative data from different societies.
5. Awareness campaign to provide guidelines for water conservation
6. Introducing water reuse opinions

Direct water use manual calculation

drinking, bathroom sinks & toilets, utensils and labs etc.

Indirect water use

It is also termed as virtual water consumed by diet, drive, clothing, washing, electricity, smart phone, laptop, paper, plastic, bottles and cans, etc.

Consequences of the Research

1. A comparison between existing water consumption patterns and sustainable water use ways and means.
2. Enlisting draw backs if sustainable use is not implemented
3. Making campus public an awareness generating entity towards water sensitivity.
4. Preliminary planning for water use, conservation and management.
5. Introduce the baseline data of WF from campus to systemize and develop water management policy for future.

Survey Methodology

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Conclusion

Water Footprint (WF), is the amount of water that is used directly by someone from a tap, plus the amount of water used to produce the food eaten, the products used and the energy consumed. It is “indirect water use” or “virtual water”. With increasing population and consumption pressure it is necessary to assess and calculate water used

And water needed per person per day etc. To manage water scarcity and evaluate future demands in water policy development.

Declarations

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Conflicts of interest/Competing interests 'Not applicable'

Availability of data and material

Hafiz Hayat Campus, University of Gujrat, Pakistan.

Code availability 'Not applicable'

Authors' contributions Review and planning study description

Ethics approval 'Not applicable'

Consent to participate 'Not applicable'

Consent for publication 'Not applicable'

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