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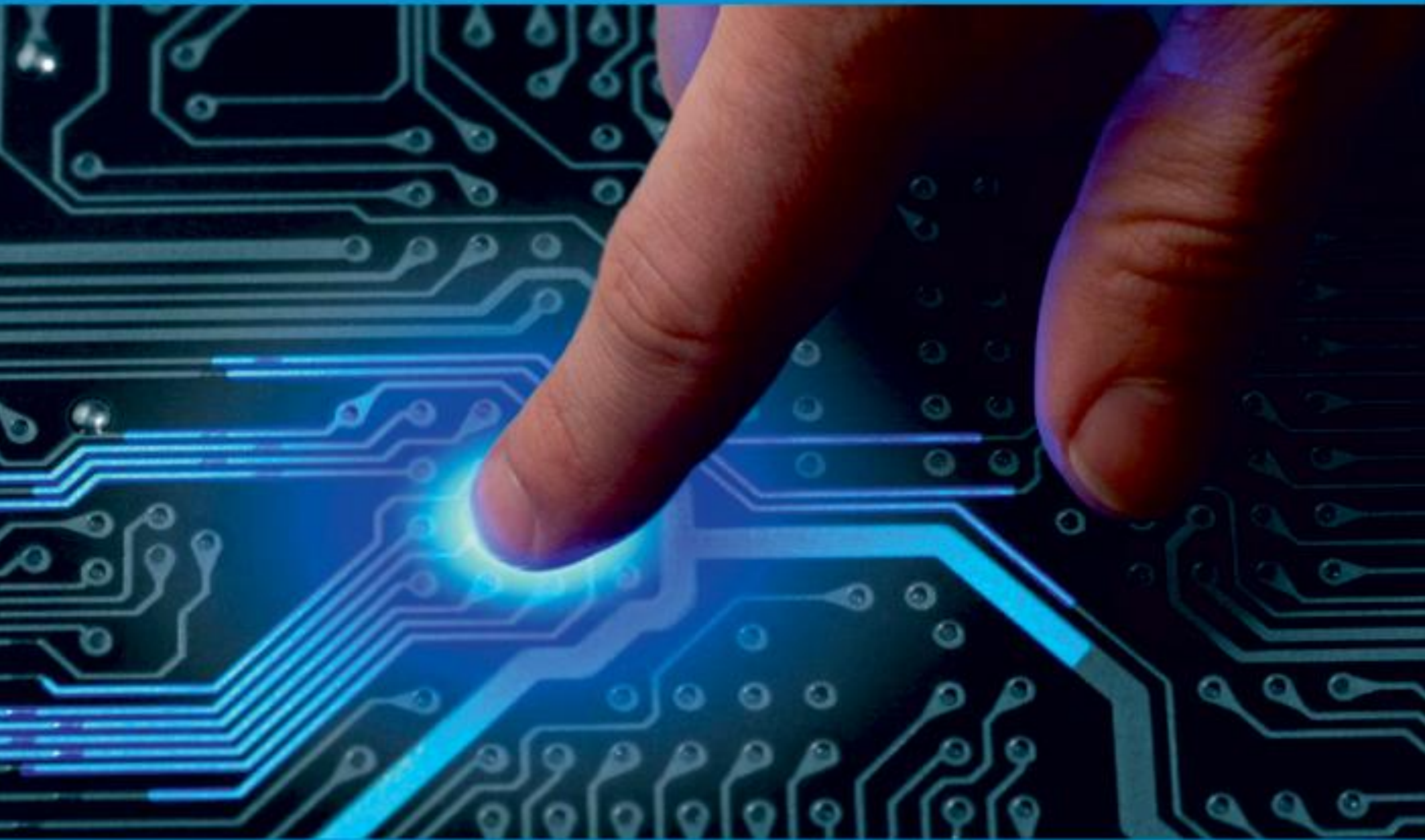

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Digital Technology to Calculate Water Footprint for Different Daily Use Items

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ABSTRACT: Freshwater is essential for life, but its scarcity is a growing concern due to increasing population and prosperity. While people primarily use water for basic needs like drinking and cooking, a significant portion is utilized in the production of various goods, known as virtual water content. This virtual water refers to the water used in producing a product, which is not physically contained within it. The concept of water footprint encompasses the total freshwater consumption throughout a product's supply chain, including green water (from rainfall), blue water (from groundwater or surface water), and grey water (used for dilution of pollutants). To address this issue, IoT and machine learning technologies are being utilized to measure the water footprint in clean and green technology. This approach allows for the tracking of water usage across various stages, such as crop cultivation, livestock raising, manufacturing processes, and energy generation. By harnessing these technologies, we can accurately assess water usage, identify inefficiencies, and develop innovative solutions for sustainable water management. Ultimately, this initiative aims to reduce our water footprint while promoting environmental responsibility.

KEYWORDS: Freshwater, scarcity, green water, blue water, grey water.

I. INTRODUCTION

Fresh water is indispensable for sustaining life, constituting a mere 2.5% of the Earth's water volume. This scarcity is underscored by the fact that 69% of freshwater is locked in glaciers and polar ice caps. The remaining 13 million km³ of usable freshwater, though essential for sustaining life, are distributed unevenly across the globe. As global population and prosperity burgeon, so does the demand for freshwater, exacerbating concerns over its scarcity. Over the past century, water usage has outpaced population growth, resulting in increased water scarcity in many regions. Presently, 1.2 billion people inhabit water-scarce regions, with an additional1.6 billion experiencing economic water shortages, thereby lacking access to safe drinking water due to inadequate infrastructure. In response to these challenges, initiatives like the Water Footprint Calculator project have emerged, serving as indispensable tools for individuals, businesses, and communities to comprehend and address their water usage. Central to the Water Footprint Calculator project is the concept of a water footprint, which encompasses the total volume of freshwater utilized directly or indirectly throughout the production and consumption processes. Unlike traditional metrics that solely consider water consumed for drinking or household activities, the water footprint extends its scope to encompass water usage throughout the entire supply chain of goods and services.

II. LITERATURE REVIEW

The concept of a water footprint encompasses the total volume of freshwater used directly and indirectly by an individual, organization, or product throughout its entire lifecycle. This includes not only the water used directly for consumption or production but also the water used in the production of goods and services that are consumed or utilized. This includes initiatives to protect water resources, improve water efficiency, and engage with stakeholders to address Water-related challenges. We aim to implement a model based on digital technology that can automatic identify whether the water is fit for use and also suggest methods to purify the water and make it fit for daily consumption and use. Nibi Kulangara Velayudhan, Preeja Pradeep, Sethuraman N. Rao, Arya Devi Remanidevi Devidas, and Maneesha

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Vinodini Rames [1] This paper offers a comprehensive review of IoT's role in water distribution systems, including taxonomy, technologies, architectures and cloud platforms. The main methodology involved in this paper is to collect and preprocess data from different growth stages of summer maize Used ResBiLSTM, to predict soil water content (SWC) at multiple depths for summer maize. R Harika, D. Pandey, A Sharma and S Sirohi [2]. In Andhra Pradesh, milk production has a significant water footprint, mainly due to feed crops. Lowering this footprint involves improving water use efficiency in crop production through better farm management, agronomic practices, and efficient irrigation systems. Identifying areas of high crop productivity, promoting low-water-consuming. Pelin Okutan, Atilla Akkoyunlu [3]. Water footprint varies across animal types, with buffalo milk having the highest footprint, followed by local and crossbred cows. The main methodology involved in this paper is the concept of virtual trade between districts is presented as a viable strategy for optimizing water resources in pursuit of sustainable milk production Zareena B. Irfan and Mohan Mondal [4] Addressing the stress on freshwater resources due to climate change and population growth requires reducing the water footprint of populations. Initiatives should focus on green and smart solutions, with active involvement of the public to ensure acceptance and effectiveness Dipti Mathur and Priti Kaushik [5]. A study examining water footprints of campus residents highlights the importance of understanding individual behaviour's. This paper mainly involves Survey methodology that allows the collection of data on water use behaviour, and providing insights into the factors influencing water footprint. Houari Yerou [6] Nation's water footprint (WF) is crucial for informed national policy development. WF, comprising blue, green, and gray components, measures human appropriation of freshwater resources. Mapping national WFs Linlin Xu and Wengang Zheng [7] .WF benchmarks incentivize industries to reduce water use and promote efficiency. Indian industrial water footprint needs significant improvement for sustainable water use, requiring government and individual initiatives to decrease WF in industries. The main methodology involved in this paper is to calculate water intensity and assessing the water consumption of Indigenous and Crossbreed cows. Abdelmadjid Saad, Abou El Hassan Benyamina, AndAbdoulaye Gamatié [8]. Sustainability hinges on managing human activities within Earth's life support systems. Current consumption exceeds the planet's capacity, necessitating interventions to promote awareness and shift towards sustainable consumption patterns. Water preservation is vital for present and future generations, especially as freshwater becomes a global concern due to trade in water-intensive goods Swadhina Koley, Jeganathan C [9] Water footprint accounting measures consumptive water use and connects it to specific locations and times, emphasizing the importance of efficient use due to limited availability. Virág Nagypál, Dorottya Ördög, Zsuzsanna László, Edit Mikó [10]. Water sustainability in hospitals is a critical aspect of responsible healthcare management, and recognizing businesses, industries, or individuals implementing water sustainability methods is essential for promoting environmental stewardship and ensuring long-term resource availability. Yazmin Lisbeth Mack Vergara, Vanderley Moacyr John [11] Begin by identifying the key factors that contribute to water sustainability in hospitals. Water volume: Total water consumption within the hospital premises, including usage for sanitation, medical equipment, and general operations. Energy consumption: Energy required for water treatment, heating, and distribution systems. Tul Kobra, Arnab Debnath, Proteeti Prova Rawshan. [12].Patient wellbeing: The impact of water sustainability measures on patient health and comfort Societal approval: Public perception and support for the hospital's water sustainability initiatives Government regulations: Po-Yuan Hsu, Yi-Lung Yeh[13].Develop a Causal Model: Construct a causal model that outlines the relationships between these factors. For instance, reduced water volume may lead to lower energy consumption for water treatment and distribution. Tanzila Younas, Usama Qadir, Nasreen Bano Warisha Zafar [14]. Develop a validation package that includes detailed information about the factors included in the causal model, their interconnections, and supporting evidence or data. Jing Chen, Shuying He, Kai Yang [15]. Engage Subject Matter Experts (SMEs). Identify SMEs with expertise in water sustainability, healthcare management, environmental science, and related fields. Taras Mykhailovych, Mykhailo Fryz [16]. Assess the robustness of the model, provide feedback on its accuracy and completeness, and suggest any necessary revisions. Iterative Refinement Based on the feedback received from SMEs and validators, refine the causal model as needed to ensure its accuracy and relevance. Jian-hua Jin, Yang-ren Wang [17]. Final Validation: Once the causal model has undergone iterative refinement and received validation from experts and validators, finalize it as a comprehensive framework for understanding and promoting water sustainability in hospitals. R. Kanmani, D. JeyaBharathi, Siva Suriya. G, A. ChristyJeba Malar, G. Lavanya [18]. The methodology described involves the development of a ResBiLSTM model for predicting soil water content (SWC) in maize fields. This approach integrates ResNet (Residual Networks) and BiLSTM (Bidirectional Long Short-Term Memory). MADO´NSKI Rafał, NOWICKI Marcin, and HERMAN Przemysław [19]. Integration of ResNet and BiLSTM Combining ResNet and BiLSTM allows for the extraction of high-dimensional residual features and bidirectional temporal dependencies. ResNet excels at capturing complex spatial features. Dongjun Suh, Hyunyoung Kim, Jinsul Kim [20]. Temporal Feature Extraction The model's ability to capture both spatial and temporal features is a significant advantage. SWC data often exhibit complex spatial patterns and temporal dynamics. By incorporating both types of features, the model can provide more comprehensive predictions, capturing nuances in SWC variations across space and time. Zhengpei Zhang, Shaoyuan Li [21]

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Performance Improvement. The ResBiLSTM model demonstrates superior prediction accuracy compared to traditional machine learning and deep learning models. This improvement in performance is crucial for applications in agriculture, where accurate predictions of SWC can inform irrigation scheduling, crop management decisions, and water resource. Salah L. Zubaidi, Hussein Al-Bugharbee, Yousif Raad Muhsen, Khalid Hashim, Rafid M. Alkhaddar and WisamH Hmeesh [22] Allocation. Weather Forecast Limitation, one limitation of the methodology is the lack of consideration for weather forecast information in the input data. Weather conditions significantly influence SWC dynamics, and incorporating weather forecasts could enhance the model's predictive capabilities by capturing the Yang Jia, b, Li Yonga, Tang Jianc, Su Yongxiana, Yang Jingfenga [27]. Through parameter calculations, including crop evapotranspiration and effective rainfall, the model determines both green and blue water footprints of kharif rice. Elnaz Ebrahimi, Babak shirazi, Iraj Mahdavi [28]. Challenges such as data constraints, dependence on meteorological parameters, and the limited scope of the study must be addressed to ensure the reliability and applicability of the findings beyond the specific region and crop examine. Hua Jin, Linwei Feng, Rui Liang, Shuyan Xing [29]. The methodology employed in this study involves conducting a case study to estimate the water footprint of a typical 30 MPa concrete. Wenge Zhang, Xinjian Guan [30]. One of the significant advantages of this approach is its ability to facilitate comparisons of water inventories, enabling the identification of opportunities for water reduction and promoting rational water usage practices among companies.

III. EXISTING SYSTEM

IoT systems face challenges such as updates, heterogeneity, standardization, security, and resource limitations. Monitoring and controlling water distribution networks in real-time is complex due to changing environmental conditions. Risks like hacking, jamming, and data manipulation pose threats to IoT integration in water distribution systems. Constraints in acquiring high spatial and temporal resolution data for remote sensing studies. Estimation highly reliant on local meteorological conditions, leading to variations in results. Difficulty in validating results due to limited impact of future weather events on SWC.Shubham Milind Phal, Girish Rao Salanke N S, Dr. Shobha G, Prapulla S B. [23]. Data Set Imbalance. Imbalance in the dataset across different growth periods may impact the model's generalization ability. Maize growth stages exhibit varying SWC dynamics, and insufficient. Meo Vincent C. Caya, Adrian G. Narciso, Mariah Camille A. Roque, Wen-Yaw Chung [24]. Addressing data set imbalance through data augmentation techniques or balanced sampling strategies may improve model performance. Complexity and Parameter Tuning. Bheki SITHOLE, Suvendi RIMER, Khmaies OUAHADA, C. MIKEKA, J. PINIFOLO [25]. Tuning the model architecture, hyperparameters, and regularization techniques is essential for achieving optimal performance. This process may demand additional computational resources and expertise in deep learning and optimization techniques. Misagh Faezipour, Susan Ferreira [26]. The methodology outlined for assessing the water footprint of kharif rice cultivation in the cropping year 2015-16 is a comprehensive approach that integrates remote sensing data, meteorological parameters, and crop-specific calculations station and institutional data availability for irrigation information. Implementing IoT systems in water distribution networks presents a multitude of challenges that must be addressed to ensure their effectiveness and reliability. These challenges include the need for regular updates to keep pace with technological advancements, the inherent heterogeneity of infrastructure in water distribution systems, and the lack of standardized protocols and communication interfaces, which can hinder interoperability. Moreover, ensuring the security of IoT devices and data is paramount, as risks such as hacking, jamming, and data manipulation can compromise the integrity of the entire system. Real-time monitoring and control of water distribution networks are further complicated by the dynamic nature of environmental conditions, requiring accurate and timely data collection and analysis. Additionally, acquiring high-resolution data for remote sensing studies is constrained by resource limitations and access restrictions, leading to challenges in accurately estimating water usage. Validation of results is also hindered by the scarcity of ground assess the reliability of IoT-generated information. Addressing these challenges requires a comprehensive approach involving technological innovation, regulatory measures, and collaboration among stakeholders to ensure the successful integration of IoT systems in water management practices. The absence of water usage optimization in the system represents a significant drawback in terms of efficiency. Without mechanisms in place to optimize water usage, the system may fail to utilize resources effectively, potentially leading to wastage and inefficiencies. Additionally, the system's inability to handle variations in user behavior, external temperatures, and other variables further exacerbates this issue. Such variability is inherent in water usage patterns and environmental conditions, and without dynamic adaptation capabilities, the system may struggle to respond effectively to changing circumstances. Moreover, the static design of the current system, which relies on a fixed amount of water without considering different user needs and scenarios, limits its adaptability and flexibility. A more dynamic and adaptive approach to system design is necessary to address these shortcomings and ensure optimal water usage efficiency in various contexts and conditions. This could involve implementing smart algorithms, sensors, and controls to

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continuously monitor and adjust water usage based on real-time data and user preferences, ultimately improving overall system performance and resource utilization.

Country	Wood Pulp for paperboard	Pulp of other fiber for paper and paperboard	Dissolving Pulp, wood +other Raw materials	Paper and paper board	Utilization of Recovered paper for making paper and paperboard
Australia	923	0	0	3024	1691
Brazil	24,969	-	670	11,040	5090
Canada	13,600	-	-	8600	2850
China	21,150	5580	-	124,320	66,420
America	40,822	-	-	65,959	29,054
Japan	7579	4	155	13,661	15,947
Korea	277	-	-	11,254	8315
Thailand	1082	151	89	5374	5201

IV. PROPOSED SYSTEM

Objectives of the Proposed Work

The project's primary objective is to leverage digital technology, specifically Internet of Things (IoT) and machine learning, to quantify water footprints associated with various daily use items. By utilizing machine learning algorithms, such as K-Nearest Neighbours (KNN), the project aims to categorize water consumption into different types, namely green, grey, and blue. This categorization helps in understanding the sources and impacts of water usage, thus facilitating targeted interventions for conservation and management efforts. The overarching goal of the project is to address the growing demand for freshwater driven by population growth and increased prosperity, as well as the pressing issue of water scarcity in many regions worldwide.

Through the implementation of machine learning algorithms, the project seeks to accurately identify the percentage of water consumption attributed to different activities or products. This data can then be used to inform decision-making processes aimed at reducing water usage and promoting sustainable practices. Additionally, the project envisions developing a system capable of measuring water purity and displaying relevant values on an LCD screen. Furthermore, the system aims to provide real-time updates of water footprint calculations to a webpage, allowing for continuous monitoring and analysis of water usage patterns. Overall, the project represents a holistic approach to addressing water scarcity and promoting responsible water management practices through the integration of digital technologies and innovative solutions.

$$Aij=\begin{cases} 1, there\ is\ apath\ directly\ from\ node\ ito\ j \\ 0\ otherwise \end{cases}$$

Calculate the energy loss Hij =Hi – Hj, Where Hi is the head of node i. The outcomes of this project hold significant potential for addressing pressing water management challenges and promoting sustainable practices. By leveraging digital technology, specifically IoT and machine learning, to calculate water footprints for different daily use items, the project can achieve several key outcomes:

Increased Awareness and Understanding: By categorizing water consumption into green, grey, and blue categories, the project can enhance public awareness and understanding of the sources and impacts of water usage. This knowledge can empower individuals and communities to make informed decisions and take action to reduce their water footprint.

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Efficient Resource Management: Through the utilization of machine learning algorithms, such as K-Nearest Neighbours (KNN), the project can accurately identify the percentage of water consumption associated with different activities or products.

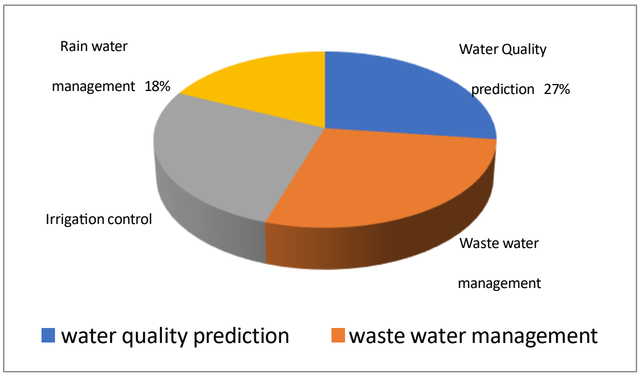
Mitigation of Water Scarcity: By addressing the increasing use of freshwater due to population growth and rising prosperity, the project can contribute to mitigating water scarcity in many parts of the world.

Development of Monitoring System: The ultimate goal of developing a system capable of measuring water purity, displaying values on an LCD, and updating them to a webpage represents a significant outcome.

Overall, the outcomes of this project have the potential to drive positive change in water management practices, promote environmental sustainability, and contribute to the achievement of global water security goals.

V. METHODOLOGY

It mainly aims in checking the water use ability using the sensors before providing the actual water foot prints. Mainly aiming to show the alkalinity and humidity of the water that is being considered for water footprint calculations, various indication methods are being used where we depict it as whether it is a grey water, green water or blue water.



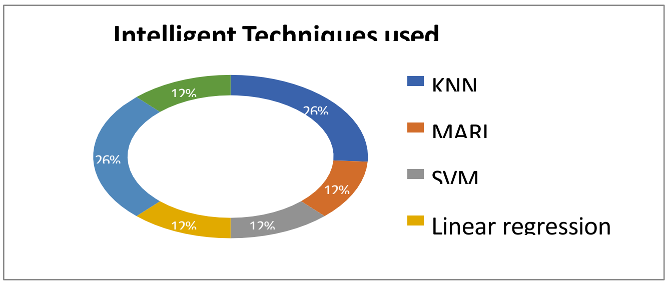
Outcomes of the Proposed System

DHT Sensor: This nifty sensor acts like a tiny weather station, measuring both temperature and humidity. It likely uses a capacitive element to detect changes in moisture content of the air, which correlates with humidity.

pH Sensor: This sensor dips its toes into the solution (literally or figuratively) to determine its acidity or alkalinity. It measures the electrical potential generated by the concentration of hydrogen ions (H+) in the solution.

Microcontroller (Arduino Uno): This serves as the brain of the system. It collects the raw data from the sensors, which might be in the form of voltage changes or resistance values. The Arduino then converts this data into digital signals.

Wi-Fi Module: This nifty gadget allows the Arduino to connect to a wireless network. Once the data is processed, the Arduino can transmit it to a designated server.



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Data Analysis and Display (Possible Scenario):
PC (External Machine): While not explicitly shown in the data flow, the diagram suggests the data might be sent to a computer. This computer could potentially house a machine learning model. This model, after being trained on vast amounts of environmental data, could analyse the sensor readings and identify patterns or potential issues. For instance, in a greenhouse, it might predict if humidity levels are too high for optimal plant growth.

Web Interface (User): The processed data, or even the raw sensor readings, could be displayed on a user- friendly web interface accessible through a computer or phone. This allows for remote monitoring of the environment. Imagine a farmer checking the pH and temperature of their hydroponic garden from their smartphone.

Additional Considerations:
Power Supply: The system needs a power source to function. This could be a battery or a wall adapter depending on the application.

Alerts: The system might be configured to trigger alerts if sensor readings fall outside a pre-defined range. This could involve the buzzer sounding or an email notification being sent.
Overall, this system demonstrates how various components can work together to create a versatile environmental monitoring tool.

VI. CONCLUSION

In conclusion, utilizing digital technology for calculating water footprints in daily use items offers valuable insights for informed and sustainable decision-making. This approach enhances our understanding of water consumption patterns and allows for more accurate assessments across the supply chain. Real-time data access enables dynamic calculations, identifying opportunities for conservation. Furthermore, digital tools promote transparency, fostering shared responsibility among stakeholders. Despite challenges like data accuracy and privacy concerns, ongoing collaboration is essential for refining methodologies and advancing water footprint calculations, crucial for sustainable practices.

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