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Attributes For Water Sustainability Index (WSI) For Office Building In Northern India

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"Water is the most critical resource issue of our and our children's lifetime. The health of our waters is the principal measure of how we live on the land." Luna Leopold

Abstract

Sustainability issues are generally point of discussion now days from micro to macro level. It is a term which indicates the wise use of the natural resources so, as to meet the needs of today without compromising the rights and availability of the future generations for the same. In the same perspective, Water Sustainability can be dealt with utmost care and sensitivity. The day today water consumption and its availability on the universe makes us understand to improve our water management system adopted or to be planned for a habitable space. The water management system is highly concerned and dependent over some of the basic attributes known as Components, Indicators (Sub- Components), Sub-Indicators with their threshold values. These terms represent the present actual condition of the water and sustainability related issues, so that the alarming position, if any, can be dealt carefully on priority with making changes in the plans therefore adopting better policies. The basic features of these parameters/attributes are Simplification, Quantification and Communication, therefore helpful to think about the interplay of Natural, Social and Economic system in the use of water for a Sustainable Development.

Key Words: Water Sustainability, Components, Indicators, Sub-Indicators and Threshold.

Introduction

Sustainability of water resources is essential to ensure that available water can be used by both present and future generations. To ensure sustainability, a comprehensive knowledge of the current conditions of water resources is necessary. Once this information is obtained, relevant programs can be designed to improve the quality and

use of water resources. A water sustainability index is a useful tool to obtain information on the current conditions of water resources. It can also be used to identify all factors contributing to these conditions, to assist decision makers prioritizing water issues, to design programs related to water resource improvement, and to communicate the current status of existing water resources to the general community. In the recent past, several indices related to water resource sustainability have been developed. Even though there have been some successful experiences with the implementation of existing sustainability indices, they are not fully applicable in other regions or countries, since most of these indices have been developed for specific regions or countries. This study aims at developing a water sustainability index for institutional buildings (Office) in Northern India, which can be used as a tool to improve the management of water resources in the region.

Defining Sustainability

The most widely known definition of sustainable development was put forth by the Brundtland Commission in 1987 as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs." Sustainability is a complex subject and clear definitions of key terms such as sustainability, stability, equilibrium, limits, thresholds, and needs can enable a common understanding.

Rather than choosing a strict definition of sustainability a set of four sustainability principles for water resources management are proposed as under:

1. **The value and limits of water.** Water resources are the basis of life and provide great value. While water is abundant, people need to understand and appreciate the limits of water resources in many regions, the environmental and economic costs of damaging water resources, and the risks to people and ecosystems of unbounded water and land use.
2. **Shared responsibility**. Because water does not respect political boundaries, its management requires shared consideration of the needs of people and ecosystems up and downstream and throughout the hydrologic cycle.
3. **Equitable access**. Sustainability suggests fair and equitable access to water, water dependent resources and related infrastructure.
4. **Stewardship.** Managing water to achieve sustainability challenges, while meeting today's needs to address the implications of our decisions on future generations and the ecosystems upon which they will rely.

The discussion of the sustainability of water resources occurs within the context of the major driving issues of population, income, land use, climate change, and energy use. All of these key drivers affect water allocation through the demands for various uses. In some cases, the water resources themselves may be changed by major shifts in these drivers. For example, with climate change, we could see increased salt water intrusion into freshwater resources because of more frequent storms and possible sea level rise[1].

Representing Sustainability with Systems Concepts and Indicators

The sustainable development of water resources is a multi-dimensional way of thinking about the interdependencies among natural, social and economic systems in the use of water. The systems concepts to understanding of world. In the case of water resources, systems concepts represent those components and processes in our world by which water moves from place to place, interacts with other components of the ecosystem, and is used by humans. Understanding these components and processes is essential to identifying key indicators. We define indicators as measures that present relevant information on trends in a readily understandable way. Indicators can be presented in the form of numbers, charts, graphs, or maps[2]. A good indicator sends society an important signal.

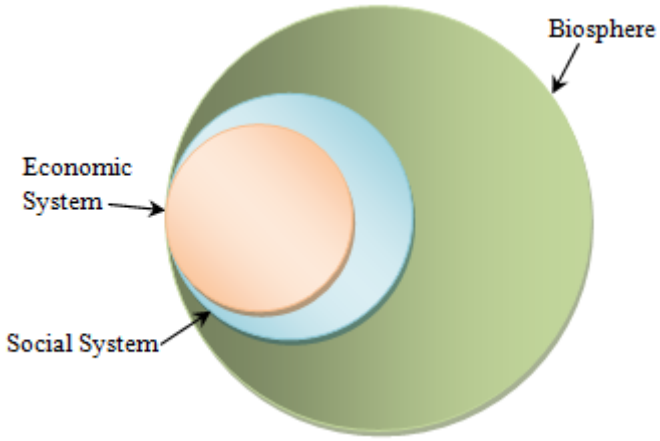

Figure 1: General Systems Perspective

Sustainability Indicators and Their Function

Indicators are quantified information which helps to explain how things are changing over time. Indicators are natural, everywhere, part of everyone's life. Intuitively we all use indicators to monitor complex systems we care about or need to control. Indicators are a necessary part of the stream of information we use to understand the world, make decisions, and plan our actions. The Principal objective of sustainability indicators is to inform public policy making as part of the process of sustainability governance. Sustainability indicators can provide information on any aspect of the interplay between the environment and socio-economic activities. Building strategic indicator sets generally deals with just a few simple questions: what is happening? (Descriptive indicators), does it matter and we are reaching targets? (Performance Indicators), are we improving? (Efficiency indicators), are measures working? (Policy effectiveness indicators), and are we generally better off? (Total welfare indicators).

There are three basic functions of indicators-simplification, quantification and communication. Indicators generally simplify in order to make complex phenomena quantifiable, so that, information can be communicated.

The Indicator Framework

Indicators represent a way to measure progress. They can provide a metric for understanding the extent to which water resources are managed to meet the long term needs of our social, economic and environmental systems. In essence, they can help us understand whether or not the nation is on a sustainable course in its management of water and related resources.

Elements of Indicator-Based Sustainability Assessment

In general, the indicator-based sustainability assessment seeks to identify indicators to measure sustainability. An indicator is a measure, either qualitative or quantitative, of facts or conditions of particular issue(s). If the indicators are observed regularly, they can analyses changes during the observed period (Nardo et al., 2005). Some indicators might be grouped to form a component, or particular indicator(s) might be further explained by having sub-indicators. A group of indicators and/or components, which are combined together, is called an index or composite indicator. Nardo et al. (2005) emphasise that ideally an index should measure multi-dimensional ideas that cannot be explained by one indicator [3].

To apply the indicator-based sustainability assessment, common elements to be considered include component and indicator selection, obtaining sub-index values of components and indicators, weighting of components and indicators, aggregation of components and indicators, and robustness analysis of the index. The components and indicators provide a framework for indicator-based sustainability assessment, as it identifies all the components and indicators of the index. To assess sustainability using this approach, all identified indicators must have common unit values. The values of the indicators in common units are known as sub-index values. After all the sub-index values of the indicators are obtained, they can be aggregated to a single index value. In the aggregation, the indicators might be assigned equal or non-equal weights. The robustness analysis of the index is conducted to study the uncertainty of inputs on the index.

Selection of Components and Indicators

Components and indicators are the main elements in an index. Therefore, in developing an index, selection of components and indicators is extremely important. Components and indicators for an index are commonly selected through a literature review on previous sustainability frameworks and existing sets of components and indicators (Chaves & Alipaz, 2007; Policy Research Initiative, 2007; Sullivan & Meigh, 2007). Generally, an initial set of components and indicators is identified, based on those reviews. This initial set is then refined through discussion with key stakeholders (Policy Research Initiative, 2007; Sullivan & Meigh, 2007).

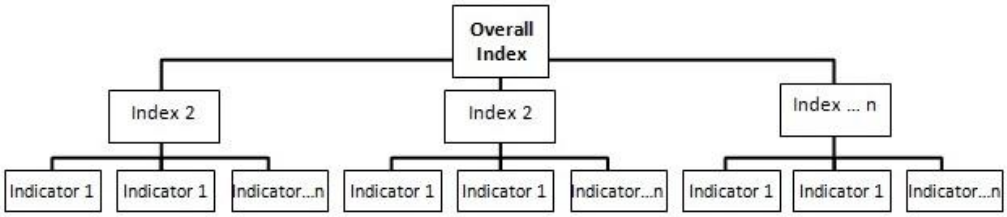

Figure 2: Relationship among Overall Index, Indices and Indicators

Liverman & Hanson (1988) suggest the following characteristics for the selection of indicators:

Sensitive to change in time
A reliable indicator must be observable throughout the particular time series of data; otherwise the indicator will not be able to provide information on how the issues related to the indicator have changed over time.

Sensitive to change across space or within groups
An indicator should reflect the changes occurred across space or within groups. If not, the indicator will be less useful to measure a condition. The Gross National Product (GNP) is an example of an economic indicator which is not sensitive to change within groups. The GNP value may increase even though for the majority of community groups the economic condition worsens. In this case, such an indicator might be replaced by one that measures the distribution of income.

Predictive or anticipatory
With regard to sustainability, reliable indicators should be able to predict or anticipate the signs of unsustainable conditions. Then, once the signal is received, the indicators can be traced to identify the main causes for the unsustainable signal.

The water stress indicator by Falkenmark (1989), for example, is an indicator which can provide an early signal, if water availability in a particular area is under threat. As this indicator is derived from two variables – population and available fresh water – further analysis can demonstrate which variable has caused the stress to water resources. Once specific causes of the unsustainable condition are identified, appropriate action to address these causes can be deployed.

Reference or threshold values available
Indicators which have been identified will be less useful when reference or threshold values to assess the indicators are not available. Therefore, if the data or reference value is not available for an indicator, the indicator might have to be replaced by a 'similar' indicator, for which its data is available.

In developing countries, this is a major concern as required data to assess the identified indicators might not be available or inaccurate (West Java Environmental Protection Agency, 2008). Therefore, it is important that during the indicator selection process, the issue of data availability is included as one of the selection criteria.

Unbiased
Biases in the selection of sustainability indicators may occur due to various reasons, such as the existing knowledge of the index developer, political interests, and the background given in the existing literature. It might not be possible to eradicate these biases. Therefore it is important, for the index developer, to identify the potential sources of biases and take necessary measures to minimize them.

Appropriate data transformation
For most indicators, the identified indicator is not the raw data. Therefore, to obtain the value for the indicator, appropriate data transformations or calculations are needed. It is important to carefully develop or adopt the appropriate method for transforming the data into the meaningful indicator value.

Integrative
The importance of integrative or composite indicators is to provide the signs on relative conditions that are not sustainable. Senior decision makers need to be informed on the conditions based on these signs, which will be analyzed to trace the main causes that lead to conditions that are not sustainable.

The concerned issues should be reflected in the indicators and the variables should be chosen / selected through an extensive review of water sustainability literature, assessment of available data, rigorous analysis and broad-based consultation with policy makers, scientists and indicator experts.

The International Institute for sustainable development (IISD) offers the following guidelines to develop effective indicators as under:

- **Availability of data:** The indicator should use good quality, affordable and readily available data.
- **Simplicity:** The information gathered for the indicator must be presented in an easily understandable and appealing way. Complex issues and calculations should yield clearly presentable and understandable information.
- **Policy relevance:** The indicator should be associated with one or several issues around which key policies are formulated. This is because sustainability indicators are intended for audiences to improve the outcome of decision-making on levels ranging from individuals to the entire biosphere. Unless the indicator can be linked to critical decisions and policies, it is unlikely to motivate action.
- **Validity:** The data used in the index should be collected using scientifically defensible measurement techniques. Methodological rigor is needed to make the data credible for both experts and the general public.
- **Time-series data:** The indicator should use data which reflect trends over time.
- **Reliability:** The same information should be provided by multiple applications of an indicator using the same data. Ideally two different researchers should arrive at the same conclusions using the same indicator**.**

Attributes Adopted To Develop Different Sustainability Indices (CWSI, WJWSI, WPI And WSI)[4]

There are a few similar sustainability indices are developed at different places of the world, so as to use them for better results as discussed above. Some of them are The Canadian Water Sustainability Index (CWSI), West Java Water Sustainability Index (WJWSI), Water Poverty Index (WPI) and Watershed Sustainability Index (WSI).A brief information about the attributes adopted to develop these indices are presented as under:

Table 1: List of Attributes Used To Develop CWSI, WJWSI, WPI and WSI

Sl.	Index	Component selection	Components	Indicators
(1)	(2)	(3)	(4)	(5)
01.	**CWSI** (Canadian Water Sustaina-bility Index)	Literature review, then expert workshop	Fresh water resources	Freshwater availability per person
				Freshwater vulnerability
				Fresh water allocations
			Ecosystem Health	Ecosystem stress
				Water quality
				Native fish population
			Infrastructure	Demand for water services
				Condition of infrastructure
				Wastewater treatment
			Human Health and Well-Being	Access to potable water
				Drinking water reliability
				Impact
			Community Capacity	Financial capacity
				Work force education
				Treatment plant operator training
02.	**WJWSI** (West Java Water Sustaina-bility Index)	Literature review, then Delphi application and in depth interview with stakeholders	Conservation	Water availability
				Land use changes
				Water quality
			Water use	Water demand
				Water access
				Water service provision
				Population pressure
			Policy and governance	Information disclosure (not analyzed due to unavailability of data)
				Governance structure (not analyzed due to unavailability of data)
				Public participation
				Law Enforcement (not analyzed due

				to unavailability of data)
03.	**WPI** (Water Poverty Index)	Literature review, then consensus opinion of experts and stakeholders	Resource	Internal water resources
				External water resource
			Access	Population with access to safe water
				Population with access to sanitation
				Irrigated land
			Capacity	Gross Domestic product (GDP)
				Under-5 mortality rate
				Education
				Gini coefficient
			Use	Domestic water use
				Industrial water use
				Agricultural water use
			Environment	Water quality
				Water stress
				Regulation and management capacity
				Information capacity
				Biodiversity
04.	**WSI** (Water-shed Sustaina-bility Index)	Literature review by authors	Hydrology	Variation in basin water availability (P)
				Variation in basin BOD (P)
				Per capita water availability (S)
				Basin BOD (S)
				Improvement in water-use efficiency (R)
				Improvement in adequate sewage treatment (R)
			Environment	Basin environmental pressure index-EPI (P)
				Natural vegetation (S)
				Evolution in basin conservation (R)
			Life	Variation in income (P)
				Human Development Index – HDI (S)
				Evolution in HDI (R)
			Policy	Variation in HDI-education (P)
				Institutional capacity (S)
				Evolution in expenditures (R)

Identification of Potential Components and Indicators

A flowchart for identification of potential components and indicator adopted in various previous studies e.g. WSI, WJWSI, WPI and WSI is followed to propose the base for the development of the WSI in the study.

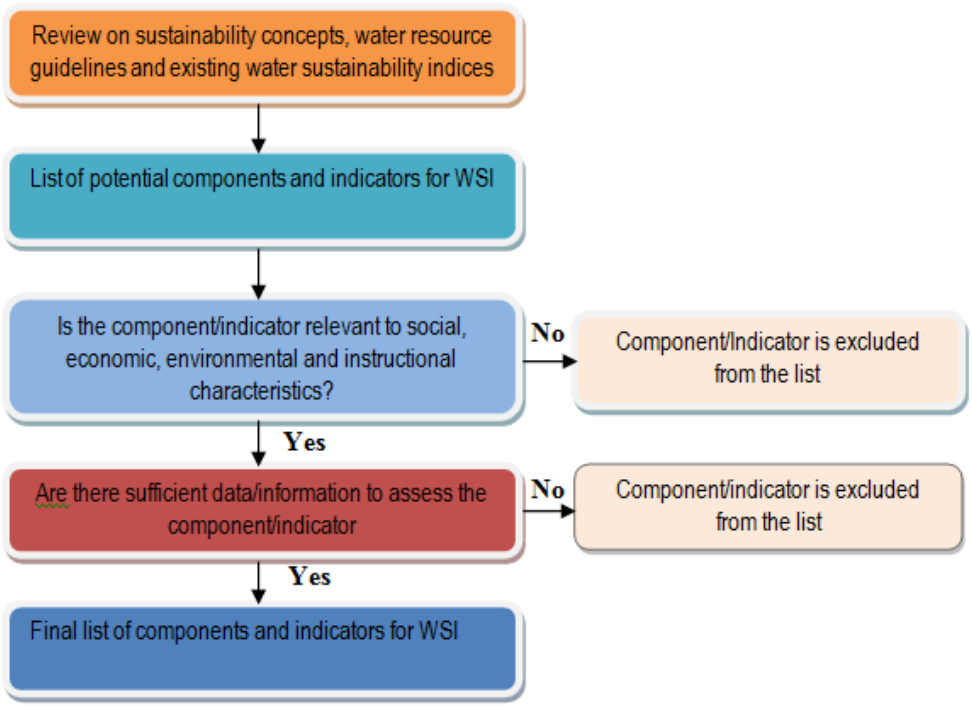

Figure 3: Flow chart for identification of potential components and indicators for WSI

The identification of the components and indicator should be based on (a) Sustainability criteria (b) water resource sustainability guidelines and (c) existing water sustainability indices (CWSI, WJWSI, WPI and WSI) [5] A four-part framework to develop the WSI after taking recommendations, suggestions and ideas from the stake holders, academicians, consultants and govt. officials from different departments based on the above mentioned guidelines is proposed as under:

Proposed Framework (Components and Indicators) for WSI for Office Building in Northern India

Sl.	Components	Indicators (Sub com-ponents)	Sub-indicators	Description
1.	Water Availability	Municipal supply or Self supporting system	-----	Readily available water for per person per year.
		Conser-vation	Reduce	Techniques & Practices adopted o reduce the water consumption.
			Reuse	Techniques & Practices adopted to reuse the waste water discharged.
			Rainwater harvesting	Techniques & Practices to conserve / collect the rain water for secondary purposes.
2.	Water use (Consumption)	Water Demand	Toilets	Water consumption per person per day.
			Pantry (Including Drinking)	Water consumption per person per day.
			Cooling (Desert Coolers)	Water consumption per machine per day as per the climatic conditions.
			A.C. (Cooling towers).	Water consumption required for cooling towers and other related purposes per Ton per day.
			Maintenance (Floor Cleansing etc.	Water consumption per sqmt. Per day for the cleaning of the built-up area etc.
			Fire fighting & misc .uses.	Not a regular feature, though average availability of water should be known for emergency purposes.
			Landscape	Water consumption (Fresh/Recycled/Rainwater collection) to irrigate the lawns/Shrubs/trees/ green areas.
			Water losses (leakages & Misuses)	Quantity of water wasted out due to the improper maintenance/careless attitude.
3.	Environment	Rain fall	-----	Quantity of water available as natural recharge due to hydrological cycle (rainfall etc.) Helps to improve the environmental conditions.
		Ground Water Level	-----	Condition/status of the ground water level indicating the environment conditions.

4.	Maintenance Aspect	Annual budget for water consum-ption	Price to pay to municipality for supply water (metered Usage) Electricity charges for pumping etc.	Expenses occurred to meet to water requirements.
		Annual maint. for infra-structure	Water lifting Pumps/Motors Supply pipe lines & plumbing items. (Metered usage) S.T.P./Waste water treatment plant	Average annual expenses for proper water management in the building.
		Action for awareness to the employees	Motivation by communication	Interest and contribution developed through motivation for water sustainability.

If sufficient data and information is not available to measure a particular indicator along with the relevancy with the subject, it may be excluded or changed accordingly.

Conclusion

In the large context of sustainability, water plays a central role and many government and private organizations have responsibility for or interest in water resources. All aspects of our society, economy and ecosystem are highly dependent on these resources.

Sustainability indicators at the national, regional and local level have become common assessment tools. There is a growing need to establish appropriate indicators to allow decision makers to make informed judgments regarding policies, programs, plans and projects. Indicators can provide crucial guidance for decision-making; they can translate physical and social science knowledge into manageable units of information to facilitate the decision-making process; and they can help to measure and calibrate progress towards sustainable development goals by providing early warning systems to prevent economic, social and environmental damage.

"*Water is a vital commodity, Common value and shared responsibility. What continues to change over time is not the drive to sustainably meet human needs to ensure respective definitions of well being, but the way we characterize our needs, water and desires and the way we approach our 'Work'… sustainable development.*

Albert Abee:

National Co-coordinator Sustainable Development

USDA Forest Service

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