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ON
INTEGRATED WATER RESOURCE MANAGEMENT – PROSPECTS AND CHALLENGES

19th September 2018

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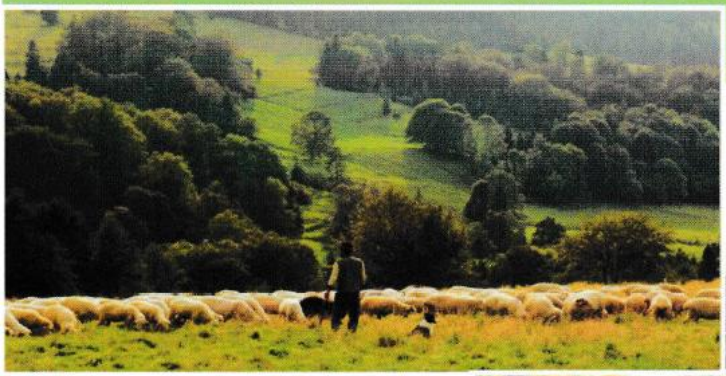

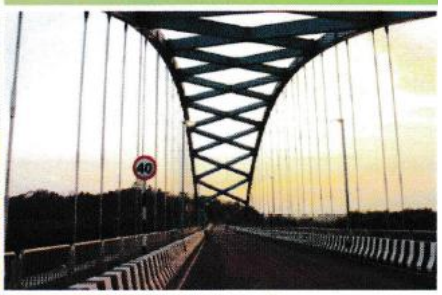

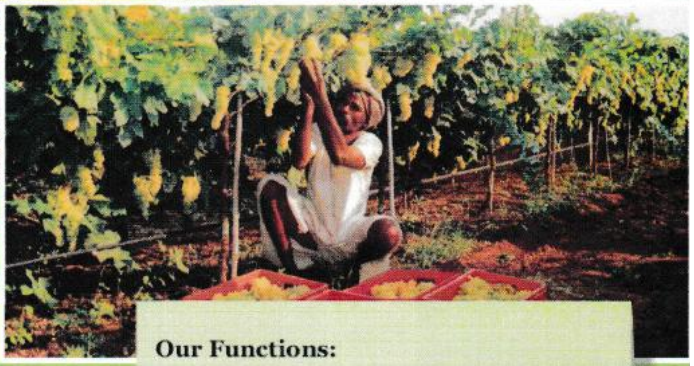

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ACKNOWLEDGEMENT

We would like to recall with gratitude our founders Shri. G.R. Govindarajulu and Smt. Chandrakanthi Govindarajulu who nurtured PSGR Krishnammal College for Women with the noble vision of Nation Building through Women Empowerment.

We thank our Managing Trustee Sri G. Rangaswamy and Chairperson Smt . R. Nandini for carrying the torch of Smt. Chandrakanthi Amma towards excellence and providing us all the necessary infrastructure and financial support for organising the Conference on "Integrated Water Resource Management – Prospects and Challenges"

We express our sincere thanks to our Secretary Dr.N.Yesodha Devi for all her encouragement and support in the conduct of the Conference and releasing the proceedings of the Conference.

We thank our Principal Dr. S. Nirmala for her guidance and providing a conducive work atmosphere for the conduct of the Conference and publishing the papers presented in the Conference.

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We are highly thankful to Dr. S. Dipu, Scientist, KSCSTE, Centre for Water Resource Development and Management, Kerala for his key note address on the Integrated Water Resource Management, Dr. Ilangovan, Rtd., Chief Engineer, PWD for his special address during the Conference. We thank G. Vedanthadesikan, Director, Centre for Rural Development, Annamalai University and Dr. N. Muthulakshmi Andal, Assistant Professor, Department of Chemistry, PSGRKCW for chairing Technical Sessions I & II respectively. We sincerely thank Dr. B.J. Pandian, Director (TN –IAMWARM), Water Technology Centre, TNAU for his Valedictory address.

We are extremely proud to have the outcome of the Conference as a special issue of the *BODHI International Journal of Research in Humanities, Arts and Science*. It was made possible only with the contribution of the participants. We would like extend our deep sense of gratitude to all the authors for their valuable views on Integrated Water Resource Management – Prospects and Challenges.

We would like to thank the faculty members of Department of Economics for their whole hearted support and co-operation.

We thank GOD for showering her blessings on us for giving us the strength and encouragement in staging the Conference and bringing out the publication.

Conference Committee

ACKNOWLEDGMENT – NABARD

We acknowledge our sincere thanks to National Bank for Agriculture and Rural Development (NABARD) for its collaboration with us.

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(1919-1986)

Smt. Chandrakanthi Govindarajulu
(1924-2002)

The vision of the institution is what the founders – Shri G.R.Govindarajulu and his wife Smt. Chandrakanthi Govindarajulu had envisioned as **"Empowering Women through Education".** Its relevance and application today stands testimony to their vision.

MESSAGE FROM CHAIRPERSON

“நீர்இன்று அமையாது உலகெனின் யார்யார்க்கும்
வான்இன்று அமையாது ஒழுக்கு”

-Thirukurral

The scarcity of water is the most important crisis that haunts not only the poor but also the rich. The gap between water demanded and fresh water availability is emerging in many developing economies. India today faces huge challenges towards ensuring water security, which include rising fresh water demand, high variability in water availability, increasing demand-supply gaps, rising water pollution, and emerging health issues. In such a circumstance, the phenomenon of an Integrated Water Resource Management has become the order of the day. In order to sustain economic growth amidst increasing pressures, particularly for the urban ecosystems, a holistic and integrated approach needs to be pursued.

Water management is management of the water resources through set policies and regulations. The sustainable water management system may involve a water management strategy, irrigation management, rain water harvesting, setting up of effluent treatment plants, watershed management and so on. Hence the Government and the Community should have the encouragement to take part in the water conservation measures in an integrated manner for sustainable development.

I congratulate the Department of Economics for organizing the National Conference on **“Integrated Water Resource Management – Prospects and Challenges”** the need of the hour.

Dr. R. Nandini,
Chairperson

MESSAGE FROM SECRETARY

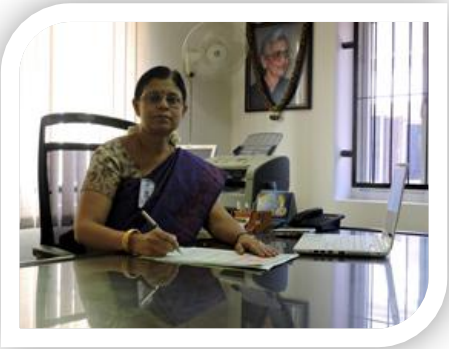
Access to water is a critical to the well-being of people in all domains – personal, familial and social. Water also makes an essential contribution to economic output. It underpins the sound functioning of natural, environmental and ecological systems. Protecting water resources, optimizing their use across these activities, and ensuring an equitable distribution of benefits from water-intensive activities should be at the centre of public policy and regulation. This is true for all levels of water governance: local, regional, river basin and central. Failure to deal strategically with these issues of allocation, resulting in a fragmented approach to water management, will jeopardize future availability and sustainability of water resources. This will ultimately reduces economic and social welfare below attainable levels.

In future, global water resources are likely to come under increased pressure. The demand for water is growing at the same time as climate change is expected to threaten its availability. Integrated Water management is a skilful balance of water supply and demand in a multidisciplinary space; water quality problems and their management now and in the future. Hence there is a need for comprehensive, basin-wide strategies in planning; and management of water resources .

This Conference is a platform to discuss and explore the different facets of Water Resource Management Practices to promote sustainability and I appreciate the efforts of all the members of the team for their contribution.

Dr. N. Yesodha Devi,
Secretary

MESSAGE FROM PRINCIPAL



Water is a fundamental resource for human development and it is vital for human survival, health and dignity. Water resources are increasingly under pressure due to population growth, economic activity and intensifying competition for the water among users. Sustainable management and development of water resources is the foundation of a green economy and essential for inclusive growth.

Integrated water resources management is based on the equitable and efficient management and sustainable use of water as a social and an economic good, whose quantity and quality determine the nature of its utilization. This emphasizes the importance of an integrated approach as well as clearly articulating the link between water resources management and the "3Es" of sustainable development namely economic efficiency in water use, social equity, and environmental & ecological sustainability.

This conference will ensure providing better awareness on Integrated Water resource Management, its challenges and measures to attain all-round sustainability. I wish the Conference all success.

Dr. S. Nirmala,
Principal

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INTEGRATED WATER RESOURCE MANAGEMENT – A TOOL FOR BETTER FUTURE

Dr. Dipu Sukumaran
Scientist, Centre for Water Resources Development and Management
Kozhikode, Kerala

"*Water is at the foundation of sustainable development as it is the common denominator of all global challenges: energy, food, health, peace and security, and poverty eradication*"-

Rio

Water is a basic need yet it is a resource that we have taken for granted. Perhaps the seeming abundance of it as the Earth is composed of two-thirds water—creates a sense of complacency without realizing that of the entire world's water, only 0.5% is suitable for human consumption. Moreover, water affects our food security as agriculture accounts for 70-85% of our water consumption. But water security is not only about the provision of sufficient water for the needs of our people and our economic activities, it is also about having healthy ecosystems and building resilience to water-related disasters, including storms, floods and droughts. Extreme weather events, such as intense or more frequent rains and increasing number of hot days, along with weak resource management are factors that lead to low water security.

Different sectors of life are affected by the water shortage. Primarily in agriculture sector, irrigation inefficiency and water pollution, such as pesticide leaching, must be addressed. We need to develop water efficient technologies such as selecting crop varieties requiring less water, to operationalize river basin management, increase irrigation water productivity and improve irrigation governance. For urban water security, water supply and allocation, flooding, and mixing of sewage water with domestic water are the main challenges. Initial recommendations include the review of current city plans, providing incentives for investors in urban water collection, construction of water impoundments and rainwater harvesters, and enhancement of water treatment facilities for industries. For the economic sector, issues on ecotourism, industrial waste and water as an energy source were raised. It is important that we maintain the integrity of our ecotourism spots, implement payments for environmental services in all major watersheds, and strictly implement the Water Code. We can also utilize water as an energy source by promoting small water turbines along river systems. Issues raised in environmental water security include the deterioration of rivers and lakes, solid waste management, mine tailings, sedimentation and erosion, as well as lack of early warning systems.

The Concept of IWRM has been around for several decades. However, its meaning in practice has been interpreted quite differently by various implementing agencies. IWRM is now advocated at various forums to combat increasing water scarcity and pollution by conservation and reuse, water harvesting and waste management. By definition "IWRM is a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems". Why the concept came? Let's check the following factors:

a. Population increased from about 5.3 billion in 1992 to about 7.6 billion today; felt disproportionally strongly in less developed countries. This has been accompanied by increased migrations of populations from rural to urban settings and high refugee movements due to climatic and social disasters with consequences for water resources management and use.
b. Demand for water has increased dramatically resulting from, inter alia, increased wealth and increased demand for food and energy;
c. Competition between uses has increased resulting in difficult allocation decisions;
d. Geo-political realignment-Several countries have dramatically grown in economic strength leading

to changes in international trade having implications for water resources management.

e. Climate change – increasing evidence of changes to the earth's climate has prompted concern and controversy. The need to cope with existing variability and to adapt and build resilience brings significant implications for water resources availability and reliability associated with the greater likelihood of extreme events;

f. In many regions water availability has been reduced due to mining of groundwater, pollution and abstraction from upstream water sources;

The concept of water as an economic good came up during the preparatory meetings for the Earth Summit in Rio de Janeiro of 1992. It was brought forward and discussed extensively during the Dublin conference on Water and the Environment (1992), and became one of the four Dublin Principles. The Dublin principles hold that: (1) fresh water is a finite and vulnerable resource essential to sustain life, development, and the environment; (2) water development and management should be based on a participatory approach, involving users, planners, and policy makers at all levels; (3) women play a central part in the provision, management, and safeguarding of water; and (4) water has an economic value in all its competing uses and should be recognized as an economic good. The first principle says that water is essential and finite, requiring an integrated approach to water resources management. The fourth principle says that water is an economic good. However, since Dublin considerable misunderstanding remained about what the concept of water as an economic good really implies.

The first aspect of IWRM states that water is not divisible into different types or kinds of water: it is a system and it is fugitive. It naturally flows into a downstream direction so that upstream interventions affect downstream availability. Water may be groundwater at some stage, at a later stage it will become surface water. Use of soil moisture diminishes the availability of groundwater; use of groundwater diminishes the availability of surface water etc. Thus any use of water affects the entire water cycle.

The second aspect of IWRM, to consider and balance all sectorial interests, limits the applicability of market principles as well. The water "market" is not homogeneous. Different sub-sectors (agriculture, industry, power, transport, flood protection) have different characteristics. The third aspect, calling for long-term sustainability, also makes the application of market principles difficult. This, like the previous aspect, illustrates that market thinking in this limited sense goes against stated policy objectives, and that additional state control is always likely to benecessary.Finally, the aspect of participation, this aspect further complicates the role of economic pricing in the allocation of water. It is for instance difficult to assess environmental externalities and internalize them in the price of water, especially in situations involving conflicting interests.

Sustainable water management (SWM) requires allocating between competing water sector demands, and balancing the financial and social resources required to support necessary water systems. The primary objectives of sustainable water management are for the three main focus areas; Urban, Agriculture and Ecosystem need. Sustainable development in urban areas requires reliable, equitable, and easily accessible water. Providing water to the rapidly growing urban populations in developing nations like India creates a complex logistic and economic problem. The primary functions of urban water management include meeting hygiene, drinking water, drainage, urban agriculture, and recreational needs. Meeting these needs while protecting natural resources and human health, especially if water is scarce, is the key to sustainable development. About 70% consumption of water accounts for agricultural use worldwide. Sustainable agricultural water management objectives include attaining food security and maximizing food water productivity in rainfed and irrigated agriculture. Evaluation of environmental sustainability is required concurrently with development planning to protect ecosystem services. Integrated modeling is a common approach for evaluating impacts between the human and natural environments.

Integrated water resource management cannot be explained without the role of women. Women are most often the collectors, users and managers of water in the household as well as farmers of irrigated and rainfed crops. Because of these roles, women have considerable knowledge about water resources, including quality and reliability, restrictions and acceptable storage methods, and are key to the success of water resources development and irrigation policies and programmes. The economic value of this unpaid contribution of women in water management is enormous: in India it is estimated that women fetching water spend 150 million work days per year, equivalent to a national loss of income of 10 billion Rupees.

Water has been vital for religious symbolism and ritual throughout human history. Hindusin India consider the river Ganges an embodiment of the goddess Ganga. This makes the Ganges River both a symbol of life and a place where one can wash away spiritual impurities, thereby drawing closer to the sacred source of life. We Indians celebtate "Pushkaram" is an Indian festival dedicated to worshiping of rivers. It is celebrated at shrines along the banks of 12 major sacred rivers in India. Rivers like Sindhu, Ganga, Narmada, Saraswathi, Godawari, Krishna, Cauvery, Thungabhadra, Tapthi were worshiped. In a similar way, ancient Jewish tradition calls people on special occasions to cleanse their bodies spiritually by immersion in a 'mikveh' bath. For Muslims, ablution with water is an obligatory preparation for daily prayer. The prophet Mohammed states in the Qur'an: "*O you who believe! When you rise up to prayer, wash your faces and your hands as far as the elbows, and wipe your heads and your feet to the ankles*" (5:6).In Roman Catholic Christianity, water can be ritually blessed and serve as a spiritual symbol of God's protection over a person or group touched by this Holy Water. Symbolizing both purification and protection, Catholics often dip the fingers of their right hand into a Holy Water font and make a Sign of the Cross as they enter (purification) and leave (protection) a church. Many Eastern Orthodox Christians also drink a small amount of blessed water when saying their morning prayers or put a little holy water in their food as they cook their meals. In the sacrament of Baptism, Christians have water poured over them or immerse themselves in water to be cleansed of sin and admitted into the Christian community. In the Roman Catholic ritual, the community prays, "In Baptism we use the gift of water, which you have made a rich symbol of the grace you give us in this sacrament".

In India, the focus on IWRM has shifted from supply driven to a demand responsive approach. The mainstream definition of IWRM has been critiqued for being ambiguous and imprecise undermining it to be a process and people oriented approach for sustainable development. Another important factor is that most of river basins in India are interstate. Parliament has the highest authority over water resources in the country but, existing laws including provision for interstate water tribunals have not been helpful for IWRM. According to the National Water Policy of India (1987 and 2002) water in the country will be managed for the public interest and following national perspectives. Water Acts, Rules and Regulatory conditions are not conducive to establishing organizations that require a cross disciplinary and integrated approach to resource management. Thirdly, Government provides irrigation water at highly subsidized rates. Wasteful and distorting subsidies hamper water savings and efficient and environmentally friendly use of water resources.

Integrated Water Resources Management should be promoted as the approach best suited to deal with the complex relationships between water users and water resources and to achieve the efficient use and equitable allocation of water on a sustainable basis. Adopting an IWRM approach can assist in reducing, leakage, operational costs, public expenditure on water related health issues, costs for cleanup of pollution events, costs from flood damage, the need for infrastructure development. Financial sustainability of government can also be improved through increased revenue through: improved payment for reliable services, better access to water for productive uses and increased opportunities for economic development and reduced unaccounted water.

TRANSBOUNDARY RIVER BASIN ISSUES – A VIEW

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Abstract

The issue of water has become a world side phenomena. On the one hand we witness worst flood and on the another hand drought. The distance between the drought affected area and the flooded area is less than 100Km. For example, when Cauvery is over flooded, the drainage canal kolidam is over loaded with he result the adjacent agricultural fields have been washed out and affected the production and productivity. Whereas the area where kolidam flows, the temperature is more than 40 degree. When Tamil Nadu begged for 12 TMC of water for their survival of agriculture, now more than 50 TMC goes towards the sea. What is reason for that? River basin management does not work properly and even we can say that there is no river basin management at all. This paper addresses the issues in Transboundary River Basin Management.

Introduction

Water resources development projects on joint rivers especially on upstream, causes difficulties for utilities in downstream which basically relates to countries national security. In Asian developing countries where water is the axis of development, water equitable distribution on the basin of the internationally recognized laws and regulations against an executive guarantee is very important. Furthermore, the management of joint basin from the point of view of water resources quality, ecology and erosion controlling, play an important role in the neighbouring countries and international relations. Generally, in the recent century threshold, water distribution and management will get the priorities in water crises in national security will be exposed to changes that the water resources management might be exchanged for a principle component in development, national security and public welfare.

Transboundary River Basin Issues

The concerns for the management of transboundary river basins have different trajectories in different countries. The major concern in semi arid and arid regions is the water scarcity, where as in well rainfed regions, water quality and flooding are the issues of greatest concern. Secondly, water consumption differed from region to region. Thirdly, total national per capita consumption including all economic uses is very uneven. Fourthly, people in different regions have tended to view water differently.

General Principles

Normally, governments try to base their policy on a number of principles that have general validity which are often also underlying international policies:

1. Governments should supply security to the people, including safety, food security, health care, protection against disasters, risk avoidance, conservation of natural resources and merit goods.
2. Each nation has the rights to develop its own policies, laws and institutions and their own strategies for natural resources development and utilization.
3. All people have basic right of access to resources for their survival and development.
4. Future generation should not deprive from access to an adequate resources base, although the resources base itself may change of composition.
5. Who inflicts damage on the natural resources system should pay for the damage.
6. Responsibility of upstream water users to downstream water users.

Critical Objects

There are some critical objects with respect to the sharing of international rivers which yield the following:

1. Equity and sustainability are fundamental guiding principles of sharing and utilizing water, at the local, district, provincial, and national levels.

2. River basins do not respect village, district, provincial and national boundaries. We should not attempt to fit the water in to these institutional boundaries.
3. Nations may develop policies and plans which are not compatible.
4. Reluctance of upstream users to take the problems of downstream users at heart.
5. There are often gaps between policies, plans and practices.

The above discrepancy has given rise to an increasing importance of public participation in the formulation of policies, plans and in operational decision-making.

New developments may require new legislation, information, approach, technologies and new procedures of weighing alternative operational scenario for planning and decision making.

Foundation

Integrated water resources management, should be the foundation supporting the management of transboundary river basins, taking as a starting point the principles of Dublin and Rio. These principles are the key concepts to integrated water resources management and the basis of the activities of the global water partnership, which was launched as a response to human impacts of water scarcity and pollution worldwide. The Copenhagen informal consultation in 1991 concluded that integrated water resources development and management means the development and management of water resources based on both their use and protection, and considering all sectors and instructions which are and affect water resources. Chapter 18 of agenda 21, adopted during the earth summit in Rio de aneroid in 1992, formulates the objectives of integrated water resources management thus: to promote a dynamic, interactive, iterative and multi sect oral approach to water resources management that integrates Technological, socio- economic, environmental and human health consideration.

The statement of the Dublin conference on water and Environment seems to equate the word 'integrated' to 'holistic' linking social and economic development with protection of Natural ecosystem (ICWE1992). It is further noted that the holistic approach would imply to look at the whole water cycle as well as intersectoral needs. Koudstaal et al. 1992, express that the word integrated refers to the interaction between quality, quality, environmental sustainability, institutional arrangements, public participitation, implementation aspects and capacity building. According to physical and non-physical dimension. The physical dimension refers to location (upstream and downstream interaction), type (surface and ground water) and quality which deal with physical, biological and chemical attributes. The non-physical dimension involves interests of different water users in all sectors of national economy including water supply, agriculture, hydropower, industry, fisheries, recreation, environment and conservation which is laid on government policies, national budget, action plans. Basic elements for sharing international rivers are the realization that the management of water resources should be done in a fully integrated fashion. There are three bases to arrive at a balanced and equitable sharing of international waters via:

- Political basis
- Legal and institutional aspects
- Technical cooperation

Political basis is responsible for an enabling environment and the legal and institutional aspect take care of water laws and institutions, while technical cooperation is the least important and centre part of the frame-work. All three bases are necessary and should be compatible whit each other. If one of the bases is weak, the sharing of international river basin may not be firmly embedded and is prone to unbalanced management decisions.

Political Basis

Political basis are important impacts in the policy making process of society. They offer criteria which allow governments to prioritize certain policy area as being more important than others. Political basis identify social groups whose interests are to be served. They describe the style with which political action is implemented. In order to highlight the possibilities for political alteration, the case of demand management is discussed as an example. A large variety of solutions have been proposed to meet the increasing demand for water in a region. These can be classified into three types, namely: increased supply, re-allocation of existing resources and efficiency improvement. Turan (1993), has argued that a fourth type of solution (high level water use) should also be entertained. Furthermore, even if all the preceding solutions are tried, a point may still be reached where no more water is available. Those, limitless of water

availability cannot avoid looking for ways to change the political trends towards new policy (high level water use).

Sect`oral and Cross-border Integration

Transboundary water resources and their use are of great importance to riparian countries. Chapter 18 of agenda 21 expresses the need for cooperation among these countries taking into account the interests of all countries,. It further expresses a need for riparian countries to formulate water resources strategies, prepare action programmes and consider when appropriate, the harmonization of those strategies and action programmes.

Countries sharing international rivers face two problems: the first is to manage the water resources holistically and second is to share the resources internationally. Thus the management of shared river basin requires the riparian countries to consider sect oral and geographical boundaries. The responsibility of these countries is to create an enabling environment that inters-sectoral and international cooperation and planning in such a way that the waters are shared equitably and sustainably. For instance, annual floods have been regarded as waste water, but during last few years there is a growing acknowledgement that such flood may be highly protective in agricultural term as it ensures the recharge of ground water aquifers from which thousands of villages. Draw their water and hence flooding has valuable ecological functions. Furthermore, agricultural practices in the well-watered upper reaches of a transboundary river system may focus on rainfed practices, where as in lower reaches with drier plains may be oriented towards irrigation as the preferred solution to secure food production.

International Collaboration

This is an important point, showing that most countries believe in international principles and also recognize that riparian countries are mutually dependent and emerging problems may be resolved by signed agreements. The following aspects are instrumental steps to bring international Cooperation in water resources management.

- Good neighbourliness

When mutual respects exist, a worthwhile strategy is to urge each country to try to fully and thoroughly appreciate the different types of interest of all riparian countries have in the water. It may be also noted that uncertainties remain in international collaboration and riparian countries may recognize this uncertainty dimensions.

- Join activity

For successful collaboration, it is necessary that the riparian countries fully understand the complexities of the water resources processes in the entire basin. Thus a next step is to formulate activities that are mutually beneficial to riparian countries. Any Joint activity can be an important instrument to enhance mutual understanding, trust and respect.

- Creation of trust and understanding Riparian countries may benefit from existing integration agreements and the principles of international law but more important point is the exchange of information, document and expertise between neighbouring countries, as well as regular face to face or meeting between ministers, directors and specialist of the countries involved.
- Opportunity from crisis There are several natural or man–provoked crises that may be turned into opportunity for improved international cooperation.

A very clear example is the flood or drought which has affected many countries and has been instrumental in bringing about the process of international coordination.

The legal-Institutional Basis

In discussing legal and regulatory aspects of international river basin management, it is necessary to distinguish international from national legal framework. The country specific laws pertaining to the use of national waters should be consistent with those principles widely accepted to apply to international waters.

National Legal Frame Works

Many countries have recently reformed and updated their national water laws, or are currently in the process of doing so. In general, each country has developed its own way of solving the issues of planning, developing, allocating, distributing and protecting its water resources. Counties also tend to define water rights and ownership of water in various ways. It is therefore impossible to make generalized statement. One major conclusion may be made is that equitable use of water at national and international level.

It may be notified that the national water laws and regulation as to be harmonized and countries should consider regional and global agreements and common law as well as the principles behind local practices regarding the use and sharing of water resources. Furthermore, laws

are empty without the institutions and people they affect. The legal frame work should be flexible so as allow issues that are specific to the sub- regional or locality .

International Aspects

The principles of the international cooperation concerning crose-border basin have been written by the international law commission who formulated draft articles on the law of non- navigational uses of international water course in 1991 and international law association, who formulated the Helsinki rule on the use of waters international rivers in 1996. The Helsinki rules have been accepted by many countries as a basis for negotiation and is to a large extend considered as international customary law. The four basic principles was first formulated by the ILA in 1985 and recognized by ILC too appear to be the following:

- Each river or lake system draining into a single basin must be treated as one integrated unit and not separate systems.
- The principle of good faith and good neighbourly relations which expresses sharing a basin river should respect the legal rights of other riparian countries.
- A prohibition to cause appreciable harm by deprivation of water rights, pollution or other means.
- The right of each basin state to a reasonable equitable share in the beneficial user of the waters of an international drainage basin.

The philosophy behind these rules are laudable and widely shared, but the problems arises when the general principles must be specified for a particular situation. The Helsinki rules state that one should consider a wide variety of aspects, such as, the geography, hydrology and climate of the basin in each concerned state, past and existing water user, social need of a basin state may be satisfied without causing substantial injury to another state in the basin (Le Moigne et al .1994). According to postel 1992, since these principles are prone to different interpretations by the riparian countries there should be clear criteria by which to judge what constitute a reasonable level of pre-capita water use given the total amount of water available in a river basin system. Lincklaean 1996, states that despite of acceptance of international law at general level, the application of the principles in particular cases remains with difficulties. According to caponera 1992, the utilization of shared water resources, requires the riparian countries to accept the principle of community of interest.

Institutional Basis

(a) Decentralising Institutions

It is often a plea that decisions concerning with water resources management should be made at different appropriate level and is intimately related to drive towards decentralization (Eu,1996). Nicol 1996 states that decentralistion should include de concentration and devolution of responsibilities to lower levels leading to technical capacity building and participation and simultaneously, the delegation of negotiation rights and responsibity for broad policy formation to higher levels. In the other word if too much decision making power is delegated to lower level, it may in fact cause tension when international rights and allocations are concerned.

(b) River Basin Institution

The most appropriate geographical entity for the planning and management of water resources in the river basin including surface and ground water according to ICWE 1992, the effective integrated planning and development of transboundary river or lake basin has similar institutional requirements to a basin entirely within one country and should be based on the same principles. Thus, there should be two types of organizations viz: Regulatory and Executors (implementation) which should be separated from each other. For example, Joint commission might be formed as the main policy level which encompasses all riparian countries. The Joint hydrological activities might be established in the form corporation with a full legal status and specific responsibilities to execute, operate and manage a project. An effective river basin organization require strong political and financial Commitment on the part of the members, clear definitions of tasks, defined procedures for international between the river basin organization and the international agencies. A river basin organization should have well focused objectives and should concentrate on projects that form common works beneficial to several basin states. The essential function of existing international basin organization appears to be the following:

- Reconciling and harmonizing the interests of riparian countries.
- Technical cooperation.
- Standardization of data collection.

- Exchange of hydrologic and other information.
- Monitoring water quantity and quality.
- Submission for examination and approval of proposed activities
- Schemes or plans which could modify the quantity and quality of waters.
- Development of concerned action programmes
- Enforcing agreement and dispute resolution

It may be noted that one of the most important function and first duties of any river basin institution involves sharing of relevant data sets on rainfall, hydrology, dam operation and related aspects.

(c) Public –Private Partnerships

In discussing the public – private partnerships, it may be necessary to distinguish between management of water resources and delivery of water services. The management of water resources comprises the need for water, flood protection, multipurpose works, and water quality and catchments protection. It is therefore concerned with safe guarding the national interest and in a typical role of government and not suitable for privatisation. Delivery of water services involves services in water subsectors, such as irrigation and drainage, water supply and sanitation energy and other areas of water demand. In the process of process of delivery of water services, there should not be monopoly formation and other market failures.

(d) Economic Issues

The last decade has seen an increasing emphasis on the economical aspects of water resources use and development. The new Delhi statement emphasized the importance of sound financial practices with respect to drinking water supply and sanitation (UNDP 1990). According to ICWE 1992, water has an economic value in all is competing uses and should be recognized as an economic good. This recommendation was inspired by the Copenhagen informal consultation, which prepared the basis for the Dublin conference. The economic value of water was explained as follows:

"Acknowledging competing demands for a limited supply of a given quality in given place at a given time, simply means that whoever has some water available, has the choice between using that water of offering it to the highest bidder among the alterative users. If he decides to use the water himself for whatever activity he is engaged (house hold, agriculture,..) he abstain from an income he could have earned by selling this water to someone else in the community or downstream. This means that the user decides that the value of water to him is higher than the income forgone. Thus by keeping the water he abstain from an income opportunity"

A wider concept of water pricing and cost recovery is demand management. Which is the use of economic and legal incentives in combination with awareness raising and education to achieve more desirable level of water consumption? In fact, in demand management the emphasis should lay on education, administrative, legal and political actins which influence demand and at the same time safeguard equity principles.

Technical Cooperation

After establishment of political, legal, and institutional aspect impinging on the management of shared river basin, it is necessary to descend to a more concrete and practical level. A solid process of establishing international cooperation should start with the technical cooperation. Different type of technical issues indicates an increasing level of cooperation which might be as follows:

(a) Information

- Collection of data- optimization of network
- standardization of data collection
- Exchange of hydrological data and other relevant data
- Update data and information
- Calibrate data collection systems and inform data
- Joint established database
- Standardization of data processing
- Development rules for information exchange in case of such as foods, droughts and pollution

(b) Crises

Establishment of procedures to manage crises, including monitoring Warning and evacuation in case of natural or human – made disasters, such as flood tropical cyclones and accidental pollution .

(c) Human resources development and capacity building establish training relevant courses in neighbouring country; and staff of one country follows the relevant courses in neighbouring country.

(d) Joint Research

Joint research would be to strengthen and stimulate regional research on a variety of topics related to river basin management. Joint research should have a practical objective and could focuse on finding mechanisms which stimulate:

- The assessment of potential for development and availability to land and water resources within river basin
- The equitable sharing of water resources within river basin which includes the development of new rules for dam operation, by taking in account trade-offs between environment and economic aspects, agriculture and industry in up and downstream uses
- Demand management, efficient use of water resources and sustainable use of water resources
- The environmental sustainable use of lands water resources
- The effect of global processes of climate changes on water resources
- The harmonization of legal and regulatory systems at local, national and regional level.

(e) Joint Plans

Preparation of joint river basin plans, including compatible strategies for water conservation. Jointly prepared operational rules for large dams that impact on more riparian countries

- Jointly revises the legal system so as harmonize them
- Development of a long – term coordinated program of intonations and measures aimed at improving water quality in transboundary.

(f) Joint – Venture

- Preparation of action plans for demand management and joint water use
- Implementation of specific project aimed at reducing and preventing the impact of principle pollution sources (discharge limens, pollution sources control, including discharge monitoring, waste water treatment)

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URBAN DOMESTIC WATER CONSUMPTION AND SEWAGE DISPOSAL: SPECIAL REFERENCE FROM COIMBATORE CORPORATION

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Abstract

Human beings form an integral part of urban ecosystem, notwithstanding the equal space within the system claimed by nonhuman plants, animals and the pattern of vegetation. Urban ecosystem is confronted with a host of environmental issues owing to unprecedented growth of economic activities combined with lack of good environmental management. Industrialization coupled with urbanization posits formidable environmental challenges. They include, inter alia, disposal of untreated industrial emissions/effluents, vehicular and noise pollution, solid waste and sewage water disposal. Households, hospitals, traders and commercial centres are the major generators of solid wastes in urban areas, besides industrial houses. The proposed study is restricted to disposal and treatment of sewage water disposal of households from the domestic sector. The multistage sampling method were chosen for 140 households. It is conclude that drinking water consumption and availability of drainage facility for Coimbatore corporation.

Introduction

This paper mainly focused on the urban domestic water consumption, in this milieu there are two types of construction buildings has to used water consumption at urban cities such as residential and non-residential. Whereas residential purposes like cleaning utensil, washing, bathing, cooking and drinking and so on. The maximum water consumption pattern. In Asia 691 million people (every sixth person in the region), do not have access to safe, sustainable water supplies and almost half the population do not have access to decent sanitation (ESCAP, 2006). **Beit Ummar, (2010),** Residents of this Palestinian village refuses to buy the idea that the flood of raw sewage from the adjacent Israeli settlement of Kfar Etzion, that destroyed vineyards and contaminated their drinking water, was an accident.

Industrial Activities

During 1998, the Corporation initiated a series of meeting and consultation workshops with government departments, prominent citizens, city-based NGOs and others social groups to get a feedback on the improvement and requirement of infrastructural facilities in the city. The City Corporate Plan prepared in 1999 funded by TNUDP is the baseline for the report. The public participation helped in forming the goals for the vision of which following are the main goals.

Coimbatore growth is sustained by a Varity of industrial activity, which revolutionized the region's industrial scène. The revolution was set off towards the end of the 10th century when the first textile mill was set up. There are 36,579 industrial units in Coimbatore District, out of which 2462 units (Large industrial units-138, Medium industrial units-1,082 and Small industrial units-1242) are present in Coimbatore Corporation Limits. The industries occupy about 6 percent of total corporation area.

Water Supply Connections:

The water is supplied through the distribution lines to a length of 569.76 km. Also, in all the 4 zones there are about 96,543 nos. of Domestic Connections, 2718 Nos. of Non Domestic connections, 354 Nos. of non - meter basis connections and 2811 Nos. of Public fountains. The details of house service connections are tabulated in

Table-1: Water Supply Connection

Connections	Details
	Nos. of Water Supply Connections
Domestic	96,543
Non- domestic	2,718
Unmetered	354
Public Fountains	2,811

Source: Coimbatore Corporation

Sewage Generation

The total Sewage Generation in 2021 for a water supply of 110 lpcd is approximately 173MLD indicating a Treatment Capacity Constraint of about 120 MLD for year 2021Population. Since, the Water Supply availability at source is ample, the sewage generation as been considered at 135 lpcd against the requirements and the demand for future is assessed. The total sewage generation for 2026 is estimated as 150 MLD. The present treatment arrangement is waste stabilization pond, given the availability of land and low operation and maintenance costs, however given the high amount of sewage generation further option for Activated Sludge Process can be explored. Environmental Screening and Social Assessment of the Project Components, in case of Sewage Capacity Augmentation, can be carried out as separate Sub-Project and a Pilot Study for the Urban Local Body. The details of sewage generation for future are presented in

Table-2. Estimation of Sewage Generation

Year	Population	Sewage Generation MLD
2001	930,882	100.54
2006	1,009,677	109.05
2007	1,026,219	110.83
2011	1,091,759	117.91
2016	1,182,341	127.69
2021	1,288,387	139.15
2022	1,309,495	141.43
2026	1,397,442	150.92
2031	1,515,731	163.7
2036	1,515,731	177.56
2037	1,670,967	180.46

Source: City Development Plan, Coimbatore Corporation

The sewage generation is calculated based on 135 LPCD water supply and wastewater generation at 80 percent of total supply. Hence, for 2021 the sewage generation is 139.15 MLD and for 2026 the sewage generation is 150.92 MLD

Water Pollution

The City lies within the watershed expanse of the Noyyal River Basin and consists of a network of tanks and canals. About 18 tanks in and around the city act as storage and percolation tanks and are major sources of ground water used for domestic and industrial activities. Canals that act as natural drainage courses, serves as storm water drains for the city.

Material and Methods

Water as a renewable natural resource, which incidentally has no substitute, gets allocated across sectors like agriculture, industry and domestic use. Although the domestic sector requires less than 10 per cent of the total in developing countries, one fourth of population is deprived of access to potable water and 15 per cent has with covered with proper sanitation. This is achieved by conducting case studies of Coimbatore Corporation under selected with a sample of 140 households to enable to discern the actual problems at the grass root level and to suggest measures for improving the existing system.

Primary household's survey results unfolded many interesting features on economic and environmental dimensions of urban domestic water supply and sewage water disposal. There is difference in land values between the centre part of city and slum in centre part. The general myth is poor people are residing in environmentally poor area. For instance, witnessed in the primary survey that most of them belong to Scheduled Cast. This is one of the reason determined the land values. The R square value turns at to be 0.47. This shows that 47 per cent of the variations of dependent variables are explained by the land values. The time required on an average by a household is 2.3 hours for water collection in slum in peripheral. People living in peripheral slum are using (70%) cycle as mode transport for water collection from longer distance. This is one of the determinant factors about water consumption. The family size is very important as it decides one's consumption of water. Sewage disposal group had the lowest expenditure value of less than 1%, showing that households spend the least on good relating to sewage. Amount spent on domestic water is 1.6%. These are less than the expenditure on entertainment (7.6%). The per capita consumption of water for all purposes per day works out to be 202 liters and for drinking alone, the per capita LPCD is 7.5 liters.

Result and Discussion

Table 3: Distribution of per capita consumption of water

Location		LPCD	LPCD cooking	Bathing	Washing utensil	Sprinkling at entrance	Ablution	Washing cloths	Gardening	Cleaning house	LPCD
Central part of city	Mean	4.7	9.0	73.2	27.1	6.1	19.3	96.6	1.1	6.3	243.4
	N	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0
	SD	.9	2.0	18.1	8.6	2.7	5.9	24.2	7.2	2.1	44.5
	Sum	206.4	394.9	3221.9	1194.5	269.5	849.5	4249.2	47.5	275.1	10708.5
Peripheral part of city	Mean	4.6	8.1	58.9	44.3	3.9	17.3	61.0	.0	2.0	200.3
	N	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0
	SD	.9	1.3	10.9	35.5	1.4	6.3	12.3	.0	.5	46.8
	Sum	255.3	450.9	3297.6	2481.7	218.8	970.2	3413.8	.0	112.5	11214.3
Slums in City	Mean	2.5	3.7	51.2	26.2	2.0	11.1	56.1	.0	1.3	154.0
	N	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
	SD	.5	1.0	8.0	8.1	.6	2.6	8.7	.0	.3	20.3
	Sum	49.1	73.8	1023.8	523.8	40.9	222.2	1121.4	.0	25.9	3080.9
Slum in peripheral	Mean	1.9	3.0	36.1	18.3	3.8	9.3	55.2	.0	1.2	131.9
	N	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
	SD	.6	1.1	8.2	6.5	1.6	2.7	8.4	.0	.4	17.1
	Sum	38.1	59.7	721.3	367.0	76.0	186.7	1104.7	.0	23.6	2637.6
Total	Mean	3.9	7.0	59.0	32.6	4.3	15.9	70.6	.3	3.1	197.4
	N	140.0	140.0	140.0	140.0	140.0	140.0	140.0	140.0	140.0	140.0
	SD	1.4	2.8	17.8	25.2	2.3	6.5	24.0	4.0	2.5	56.0
	Sum	548.9	979.3	8264.7	4567.1	605.3	2228.5	9889.1	47.5	437.1	27641.3

For all domestic purposes the per capita consumption of water are discussed in the table 4.7. The per capita consumption of water for all purposes per day works out to be 202 liters and for drinking alone, the per capita LPCD is 7.5 liters. The percapita consumption for drinking and cooking declined from moving from central part of city to city in peripheral, slum in centre and slum in peripheral. The percapita consumption of water in centre part of the city is 4.7 liters followed by 6.4liters in peripheral city, 2.5liters in slum in centre pert of the city and 1.9liters in slum peripheral, respectively. The reason being in area requirement of water for other purposes could not be captured as respondents resorted to direct spots such as sets for use. While in centre part of city, water use for other purposes could be gauged as the respondents bring home the water for use of all purposes.

Regarding the break-up details of per capita of water used per day for different domestic purposes, for cooking it is 7liters, for bathing it is 56 liters, for utensil cleaning 32liters, for washing clothes 70liters, for house cleaning 3.1, for sprinkling house entrance 4.3, and the rest goes for personal hygiene etc.

Waste water is from human settlements in urban area. Therefore, a special attention is paid to find out the solution of urban waste water disposal. The fundamental approaches to these issues state that the quantity of waste water disposal requires an integral solution. Due to the complexity and particularity of the problems to be solved, large number of necessary historical and current data required for the efficient management. Present study address to issues like quantity of sewage water disposal is presented in table 4.. Wastewater disposal has been a common phenomenon since the early ages. However, with increasing urban population, changing lifestyles and industrialization the quality of wastewater has deteriorated over the years and hence requires treatment before it can be recycled for any purpose. With increasing urbanization and changing lifestyles, wastewater generated in the urban areas is large and continues to grow over time. As cities are the centers, their water needs usually receive a higher priority, but are subject to physical and economic scarcity constraints. Increases in urban water supply ensure increased wastewater generation. The per capita domestic waste water is 170liters.

Table 4: Quantity of sewage water disposal

Locations	Would u like to use toilet with free of cost		Total	Bath room with shower how often is used trip		Total	Toilet waste get in to		Total	Waste water from bathing and utensil cleaning			Sewage disposal	
	not agree	not willing		1 trip	2 trip		Open ditch	Corporation drainage		Statistics	Bathing	Utensil cleaning	TSWD	PSWD
Central part of city	0	44	44	31	13	44	0	44	44	Mean	232	188.43	750.46	206.87
	0	[100]	[100]	[70.5]	[29.5]	[100]	0	[100]	[100]	N	44	44.00	44.00	44.00
	0	(83)	(31.4)	(24.4)	(100)	(31.4)	0	(45.8)	(31.4)	SD	69.1	95.07	139.09	37.82
Peripheral part of city	48	8	56	56	0	56	44	12	56	Mean	177	80.07	680.69	177.81
	[85.7]	[14.3]	[100]	[100]	0	[100]	[78.6]	[21.4}	[100]	N	56	56.00	56.00	56.00
	(55.2)	(15.1)	(40)	(44.1)	0	(40)	(100)	(12.5)	(40)	SD	26	7.73	260.29	68.48
Slums in City	19	1	20	20	0	20	0	20	20	Mean	232	80.00	498.45	130.94
	[95.0]	[5.0]	[100]	[100]	0	[100]	0	[100]	[100]	N	20	20.00	20.00	20.00
	(21.8)	(1.9)	(14.3)	(15.7)	0	(14.3)	0	(20.8)	(14.3)	SD	34.6	11.47	70.34	17.29
Slum in peripheral	20	0	20	20	0	20	0	20	20	Mean	60.3	72.55	412.37	112.10
	[100]	0	[100]	[100]	0	(100)	0	[100]	[100]	N	20	20.00	20.00	20.00
	(23)	0	(14.3)	(15.7)	0	[14.3]	0	(20.8)	(14.3)	SD	9.4	13.22	75.78	14.50
Total	87	53	140	127	13	140	44	96	140	Mean	185.4	113.04	638.25	170.86
	[62.1]	[37.9]	[100]	[90.7]	[9.3]	[100]	[31.4]	[68.6]	[100]	N	140	140.00	140.00	140.00
	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	SD	72.1	74.10	221.62	59.36

Source: Primary Data, [ ] Figures in parentheses are row wise percentage and ( ) Figures in parentheses are indicate column wise percentage.

Sewage Water Disposal

The regression model elucidates the influence factors with sewage water disposal. Theoretically large numbers of variables are determining sewage water disposal. This list includes Human health affected, Family size, Type of house, CAST, Per capita Income, Period of living, Toilet facility with in your house, Education year, Value of houses, PEREXP, WTO PAY /H, Is there OHT how much capacity, HSC, Time spent, How much willing to pay for improvement and Location. It may not be necessary that all variables are their influence on the sewage water disposal.

Hypothesis - I

Human health affected, Family size, Type of house, CAST, Percapita Income, Period of living, Toilet facility within your house, Education year, Value of houses, Per capita expenditure, WTO PAY, OHT capacity, HSC is available, Time spent, How much willing to pay for improvement and Location are key factors determinant urban water disposal.

Functions: $Y = a \pm bx$

$Y = 292.5 - 26.3_{(Location)} - 28.11_{(FS)} + \text{error}$

Where, Y = Sewage water disposal

a = Constants

β_1 = Location

β_2 = Family size

μ = Error term

Nineteen variables have been identified, which include Human health affected, Family size, Type of house, CAST, Per capita Income, Period of living, Toilet facility within your house, Education year, Value of houses, Per capita expenditure, WTO PAY, OHT capacity, HSC is available, Time spent, How much willing to pay for improvement and Location. Correlation matrices were applied to understand and shortlist the number of variables, which influence the sewage water disposal. The variables such as Human health affected, Family size, Type of house, CAST, Percapita Income, Period of living, Toilet facility within your house, Education year, Value of houses, Per capita expenditure, WTO PAY, OHT capacity, HSC is available, Time spent, How much willing to pay for improvement and Location were considered for running the regression against sewage water disposal as these variable exhibit a high percentage of correlation.

Factors like β_1 Location, (1. Centre part of city, 2.peripheral part of city 3. Slum in central part and 4.Slum peripheral part) and β_2 = family size turned out to be significant ($P<0.05$). The R square value turns at to be 0.41. This shows that 41 per cent of the variations of dependent variables are explained by the independent these variables. The variable such as location and family size to came out negatively with sewage water disposal (table 4). The negative sign explains that there is inverse relationship between these factors and sewage water

disposal. It is obviously implies location as a dummy variable viz., 1. Centre part, 2. Peripheral part, 3. Slum in centre part and 4.Slum in peripheral part are key factors to determinant sewage water disposal negatively. It implies that central part of the city disposed more amount sewage water disposal. About 206 liters domestic sewage disposal are generated in central part of the city followed by 177 liters in peripheral part of city, 130 liters in slum centre part of the city and 112 liters in slum peripheral, respectively. Another crucial variable like family size are turned negative. This is shows that lower family size higher sewage water disposal. The common consumption water does not influenced by family size.

Table 4.1: Regression –Sewage water disposal

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	292.516	35.802		8.170	.000
Location	-26.265	5.449	-.447	-4.820	.000
CAST	.074	4.761	.001	.016	.988
Period of living	.516	.646	.068	.798	.426
Family size	-28.109	7.078	-.307	-3.971	.000
Education year	.527	.452	.092	1.164	.246
Value of houses	9.340E-06	.000	.083	.973	.332
					R^2 =41

a Dependent Variable: PSWD

Conclusion

Water as a renewable natural resource, which incidentally has no substitute, gets allocated across sectors like agriculture, industry and domestic use. Although the domestic sector requires less than 10 per cent of the total in developing countries, one fourth of population is deprived of access to potable water and 15 per cent has with covered with proper sanitation. This is achieved by conducting case studies of Coimbatore Corporation under selected with a sample of 140 households to enable to discern the actual problems at the grass root level and to suggest measures for improving the existing system.

Primary household's survey results unfolded many interesting features on economic and environmental dimensions of urban domestic water supply and sewage water disposal. There is difference in land values between the centre part of city and slum in centre part. The general myth is poor people are residing in environmentally poor area.

The per capita consumption of water for all purposes per day works out to be 202 liters and for drinking alone, the per capita LPCD is 7.5 liters. The percapita consumption of water in centre part of the city is 4.7 liters followed by 6.4liters in peripheral city, 2.5liters in slum in centre pert of the city and 1.9liters in slum peripheral, respectively. The R square value turns at to be 0.41. This shows that 41 per cent of the variations of dependent variables are explained by the independent these variables. The variable such as location and family size to came out negatively with sewage water disposal.

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A STUDY ON AWARENESS AND ATTITUDE TOWARDS RAIN WATER HARVESTING AMONG HOUSEHOLDS IN COIMBATORE

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Abstract

One of the biggest challenge of 22nd century is to fight against growing water scarcity. It can be solved by going in for RWH. Rainwater harvesting techniques are essential to obtain a supplemental water source for groundwater, which is being depleted through time due to development process among the countries. The aim of this study is to examine the awareness and attitude of households regarding rainwater harvesting and the problems in effective RWH in their home, using a survey of 45 households of Coimbatore. The Study showed that lack of motivation, involvement, acceptance and awareness about importance of RWH are the main reasons for not having RWH structure in an effective working condition. In addition to it, lack of space, high cost involved in RWH structure and fear of causing damage to the building were also observed as reasons for majority of the respondents for not having RWH structure in an effective working condition. The Study recommends creation of awareness regarding the importance of RWH among each and every citizen of the country together with government legislation coupled with automatic monitoring systems could bring hundred percent success in effective RWH.

Keywords: *Rain Water Harvesting (RWH), Households, Survey*

Introduction

Water is the Driver of Nature

Water is the most precious natural resource. But with the current depleting levels of water, it has become increasingly important to create awareness of water and need to save it. The main reason for the water crisis is environmental pollution. As a result of the pollution the underground layer of soil and water is depleting fast. Tube wells and taps are running dry in summer as the aftermath of this depletion. People have started starving for water, especially in the arid areas. As a result, they turn to filthy sources of water like lakes, ponds and stagnant sources. This makes them fall ill and at times also gives way to epidemics. People are not only dying of thirst but also of diseases caused by unhygienic water. Such reality forced us to adopt many ways of preserving water. One among such methods is rain water harvesting.

Statement of Problem

One of the biggest challenge of 22nd century is to fight against growing water scarcity. It can be solved by going in for RWH. People collect and store water in buckets, tanks, ponds and wells. The collected water is an effective supplement that would otherwise be lost by evaporation or by surface run –off. Today RWH has regained as most important and valuable alternative for water scarcity along with other water supply technologies. Rain water can be used for multiple uses ranging from drinking, cooking, irrigation and industrial purpose. Hence the problem of growing water shortage can be solved by RWH widely. It should start from households which will solve the problem of drinking water and for household purposes. Hence the study was conducted to know the level of awareness and attitude towards RWH among the households in Coimbatore.

Objectives of the study

1. To understand the meaning and importance of RWH
2. To assess the awareness and attitude towards RWH among the selected households in Coimbatore
3. To find out the problems in effective RWH among the selected households in Coimbatore
4. To suggest measures for effective RWH.

Limitations

Respondents are restricted Coimbatore only, who were available during the period of data collection. Results depends on the geneunity of the respondents with which they have answered.

Size Sample

45 households from Coimbatore are chosen based on Convenient Random Sampling Method .

Data Collection Techniques

Primary and Secondary Data were used. Primary Data was collected with Structured interview schedule was used to collect data from the respondents. Percentage Analysis was used to analyze the data. Secondary Data were collected from books, journals and articles related to RWH

What is Rainwater Harvesting?

Rainwater harvesting is the process of collecting the rainwater from the surfaces it falls and then collecting it for the use in the future. Usually, the water is collected from the roof and stored in a tank. It can also be stored in dams or let it fall on the ground, creating a runoff. Rainwater harvesting is sustainable, economical and safe source of good quality water if collected and stored in right way.

How to Harvest Rainwater?

There are two main methods of RWH namely- surface runoff harvesting and rooftop harvesting. Surface runoff method is used mainly in the urban areas where the rainwater flows away as the surface runoff. This runoff is then collected and stored and is used. It is also used for recharging aquifers with the help of proper methods.

In the rooftop harvest method, rainwater is collected where it falls. Here, the roof becomes the catchments and the rainwater is collected from the roof of the house or the somewhere through a proper channel. It can be used for artificial recharge system. Rooftop harvesting is effective and very economical. If used properly, it can also help in increasing the groundwater level of the area.

Merits of Rainwater Harvesting(RWH)

Following are benefits of RWH:

- It helps in reducing water supply loads and electricity bills of municipality, improve free water supply, crop production in rural areas, and thus lead to food security.
- Rain water harvesting system helps in reducing the insecurity of households or individuals in the rural areas.
- It provides easy and low cost water supply in the lack of water areas thus helps in food security and income generation.

Tamil Nadu is one of the states of India and now has been first Indian state where rainwater harvesting has been mandatory. Tamil Nadu state government has declared on 30th of May 2014 to establish around 50,000 rainwater harvesting structures at various places in the Chennai. Till now, approximately 4,000 of the temples in the Tamil Nadu have rain water tanks serving at various rituals in temples and help in recharging the groundwater.

Government Programmes

Tamil Nadu Government

Chennai Metropolitan Water Supply and Sewage Board (CMWSSB) has taken initiative to constitute a fully dedicated “Rainwater Harvesting Cell” to create awareness and to offer technical assistance free of cost to the residents and also to provide to the citizens cost effective solutions. In July, 2003 laws relating to Municipal Corporations and Municipalities in the State have been amended making it mandatory for all the existing and new buildings to provide rain water harvesting facilities.

The State has launched implementation of Rainwater Harvesting scheme on massive scale in Government buildings, private houses/Institutions and commercial buildings in urban & rural areas.

The State Government has achieved cent percent coverage in roof top Rainwater Harvesting. It has also been made mandatory to include roof top rain water harvesting structure in the plan of the building itself for accordance of approval by the relevant competent authority.

Central Government

The Apex agency for water resources “Central Ground Water Board” was formed in 1970 and frequently conducting awareness, installation programs till Now. The Central Government announced Ground Water Augmentation Awards in 2007. There are 21 Ground Water Augmentation Awards (Boomijal Samvardhan Puraskars) and this is one National Award for all categories taken together consisting of cash award Rs. 1 lakh and plaque with citation.

Data Analysis

The following table shows the analysis of the data collected for the study purpose

Table.1 Socio Economic Profile and Attitude towards Rain Water Harvesting

Sl. No.	Attributes	Category	No. of Respondents	Percentage
1	Age	20-40	13	29
		41-60	26	58
		61-75	6	13
2	Education	Illiterate	2	4
		Primary	1	2
		Middle	3	7
		High School	6	13
		Graduate	28	63
		Post Graduate	5	11
3	Type of Family	Nuclear	38	84
		Joint	7	16
4	Size of Family	2-3	12	27
		4-6	29	64
		7 and above	4	9
5	Occupation	Employed -Private	16	36
		Employed- Govt.	9	20
		Self-Employed	4	9
		Business	11	24
		Professional	5	11
6	Annual Income of Family (in Lakhs)	3-5	5	11
		>5-8	24	53
		>8-12	7	16
		>12	9	20
7	Awareness about RWH	Yes	45	100
		No	0	0
8	Sources of Awareness	Media	3	7
		Advertisement	4	9
		Government regulations	38	84
9	Do you have RWH structure?	Yes	45	100
		No	0	0
10	Type of RWH Structure	Surface Run off	41	91
		Roof Top harvesting	4	9
11	If yes, Is it in working condition?	Yes	16	39
		No	25	61
12	If No give reasons (Multiple respondents)	Not aware of the Importance	20	80
		Motivation & Involvement	19	76
		Lack of Acceptance	15	60
		Lack of Space	13	52
		Damage to Building	21	84
		Cost	16	64

- **Socio-Economic Profile of the respondents**

From the above table it is observed that majority (60%) of the respondents are in the age group of 41-60 years. Nearly 63% of the respondents are graduates. Less than 10% are having education up to primary. More than 80% of the households are living in nuclear family. Nearly 65% of the respondents are having 4-6 members in their family. In the survey it is observed that more than one half of the respondents are employed and among them 36% are employed in the private sector. 11% each of the respondents are professionals and engaged in business.

Nearly 55% of the respondents are earning an annual income of Rs. five to eight lakhs. 20% of the respondents are earning an income of more than Rs. 20 lakhs per annum.

- **Respondents and RWH**

All the respondents are aware of Rain Water Harvesting. Sources of awareness of RWH maybe media, advertisement and government regulation. 85% of the respondents came to know about RWH because of government regulation and government program.

All the respondents are having Rain Water Harvesting structures because of government norms and compulsion. More than 90% of the respondents are having surface runoff structure for RWH. Only 10% of the respondents are having the roof top RWH.

Though 100% of the respondents are having the RWH, nearly 60% of the respondents do not have it in effective working condition due to various reasons.

- **Reasons for not having RWH Structure in an Effective Working Condition:**

It is observed that 80 percent of the respondents are not aware of the importance of RWH. Due to government compulsion they have installed the RWH structure. Nearly 76 percent of the respondents do not have motivation and involvement in keeping the structure in the working condition. 84 percent of the respondents opined that RWH structure in the house may cause damage to the building. 65 percent said cost of establishing the RWH structure is high especially in the old houses. Most of the houses are small and maximum of four to five cents. Lack of space is also a reason for not having RWH structure in a working condition. Still 50 percent of the respondents are not in favour of RWH structures because they opined that it breeds mosquitoes and sustained moisture conditions in and around the house.

Hence due to lack of motivation, involvement, acceptance and awareness about importance of RWH are the main reasons for not having RWH structure in an effective working condition.

It was also observed that due to lack of space, high cost involved in RWH structure and fear of causing damage to the building were also observed as reasons for majority of the respondents for not having RWH structure in an effective working condition.

- **Suggestions for Effective Rain Water Harvesting:**

Due to government legislations almost all the houses are having RWH structure, but majority of them are not in effective working condition due to lack of awareness , motivation and involvement which is very much essential for the sustained RWH.

Hence the researcher made following suggestions:

Creation of awareness and motivation is the first step in effective RWH, which can be attained by the following ways,

- Educational Institutions should inculcate the importance of RWH by including it in the curriculum of Schools and Colleges.
- Seminars, Conferences and Workshops can be organised in RWH to disseminate updated information
- Educational institutions should organize Community Development Programme and Extension Programme regarding RWH.
- Street play and promotional activity in Shopping Malls &Parks can be organised.
- Government can launch special programme to disseminate the importance of RWH among the general public.
- Documentary movies can be played in Cinema Theaters and other Recreational Centers.
- Mass Media and Social Networking System could be effectively utilized for creating the awareness and importance of RWH in the community.
- Brand Ambassador of Sports and cine field can be utilized to popularize RWH.

Conclusion

Due to government legislations almost all the houses are having RWH structure, but majority of them are not in an effective working condition due to lack of awareness, motivation and involvement which is very much essential for the sustained RWH. By creating awareness regarding the importance of RWH among each and every citizen of the country together with government legislation coupled with automatic monitoring and control Systems could bring hundred percent success in effective RWH.

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A COMPARATIVE STUDY ON SEQUESTRATION OF LEAD (II) FROM AQUEOUS ENVIRONMENT USING AGRO WASTE MATERIALS

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Abstract

The impact of heavy metal pollution due to the discharge from metal plating industries is gaining much attention nowadays. The current investigation deals with the study on the effective sorption capacity of spent tea dust and saw dust being no cost adsorbents in the removal of Pb(II)ions. Batch studies are designed to assess the trapping potential of the chosen dust materials through variable parameters. The comparative results of Pb(II)-Tea dust and Pb(II)-Sawdust systems based on batch mode revealed that tea dust exhibited better sorption efficiency than saw dust with a marginal increase of 97% against 95%; the optimized conditions being : 0.30 mm particle size, 100 mg dosage, 10 ppm initial concentration, 15 minutes contact time.

***Keywords**: adsorption, lead ions, batch, spent tea dust, saw dust*

Introduction

In recent years, considerable attention is sufficed to study the removal of heavy metal ions employing adsorption technique using agricultural waste materials viz.,Tea dust and Saw dust. Saw dust discharged as huge piles and harmful leachates into local water systems, create environmental hazards. This has placed small sawyer and environmental agencies in a deadlock[1]. Lead is a well-known cumulative poison found in the environment mostly because of mining and smelting, battery manufacturing and its as an additive in fuel. Hence it is essential to eliminate even the traces of lead ions from drinking water and to remove lead from waste waters before they are discharged into receiving bodies. Acute Lead poisoning in humans causes severe dysfunction of kidneys, reproductive systems, liver, brain and the central nervous system. Adsorption is one of the alternatives for such cases and is an effective purification and separation technique used in industries especially in water and wastewater treatments. Cost is an important parameter for comparing the adsorbent materials. Therefore, there is greater demand for low cost alternates. Thence, use of tea dust waste and saw dust as a replacement for costly methods of removing heavy metal ions from aqueous solutions forms the prime objective of the study.

Materials and Methods

Chemicals

All the chemicals used were of analytical reagent grade. Doubly Distilled (DD) water was used to carry out the experimental studies. Stock lead solution of 1000 mg/L was prepared using double distilled water. Aliquots of the adsorbate solutions of varying Pb(II) ions concentrations were prepared by progressive dilutions of stock lead solution. 0.1 N HCl and NaOH solutions were employed to adjust the pH of the aliquots.

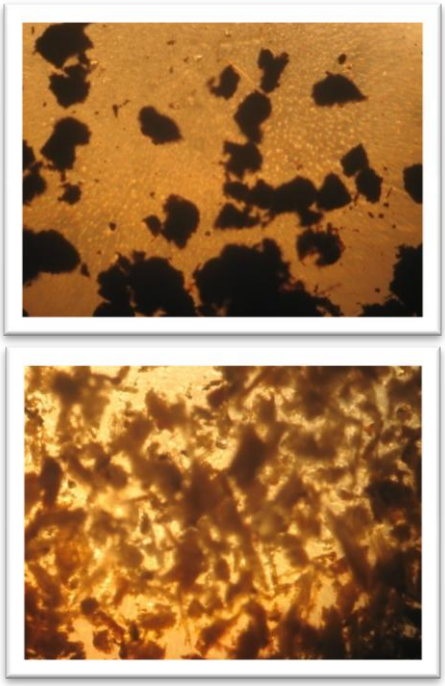
Fig 1 Image of Tea Dust

Fig 2 Image of SawDust

Batch Equilibration Method

The dust materials were dried in shadow for more than 15 days, and utilized for pilot studies. Initial concentration of lead(II) solution of different concentration viz., of 3,6,9,10,12,15,18 and 21 mg/L were employed for batch experimental verification. 100 mg of tea dust and saw dust was added in separate flasks, each containing 50 ml of Lead solution. The mixtures were agitated in a mechanical shaker at a speed of 140 rpm at an optimum pH 5. The agitated suspensions were centrifuged and the residual concentration of Pb(II) were analysed using a Varian-Atomic Absorption Spectrophotometer.

Fig 3.Microscopic structure of tea dust & sawdust (0.30mm)



The percentage of Pb(II) ions removal was calculated from the recorded concentrations using the following expressions:

$q_e = (C_o - C_e) V/m$ (1)

Removal percentage (%) = $(C_1 - C_2) / C_1 * 100$ (2)

Results and Discussions

Effect of Particle Sizes

Table. 1 Particle Sizes of tea dust and saw dust

S. No	Adsorbents	Mesh size BSS	Particle size mm	Density g/cc
1	Tea dust	85	0.18	0.2125
		52	0.30	0.1548
2	Saw dust	85	0.18	0.1488
		52	0.30	0.1441

Preliminary studies on the effect of particle size seem to indicate that the overall sorption capacity is a function of the particle size, possibly indicating a surface sorption phenomenon. The sorption capacities of tea dust and saw dust are dependent on the availability of active surface sites on the adsorbent. The maximum sorption capacity exhibited by tea dust and saw dust with particle size 0.30mm is attributed to the larger surface area. The diffusional resistance to mass transport is higher for larger particle sizes and most of its internal surface may not be utilized for adsorption[1]. Consequently, the amount of metal adsorbed is less. In view of this excellent experimental results obtained for the dusts of 0.30mm particle size it was decided to limit the discussions for the further experiments using this dimension.

Effect of Agitation Time

The minimum period of contact required for the maximum removal of Pb(II) by tea dust and saw dust was observed as 20 and 15 minutes respectively for maximum sorption of lead (II) ions to attain equilibrium. In the beginning of the sorption process, all adsorption sites on the sample surface are vacant and hence the extent of the metal ion removal is high.

Effect of Dosage

Adsorbent dose seems to have a great influence on sorption process. Dose of adsorbent added into the solution determine the number of binding sites available for adsorption. The three doses, 50, 75, 100 mg of tea dust and saw dust at was utilized for the study of dosage. A definite increase in the sorption capacity of the sorbent with dosage was evident. This is due to the large number of available adsorption sites favouring enhanced uptake of Pb(II)[9]. The rate of adsorption of Pb(II) on tea dust and saw dust was appreciable at an initial dose of 50 mg, even though an inclination was observed with doses, but not in a linear proportion. In view of this, it was decided to conveniently fix a dose of 100 mg for the remaining experiments. As like the particle size and contact time accounted for the maximum removal of Pb(II) ions, this was considered as an optimum condition for further sorption studies. Similar results were reported by Namasivayam et al.,[10] for the removal of nitrate ions.

Effect of pH

The solution pH has been reported to be the most important variable factor governing the sorption of metal ions. Experiments were set up at varying pH values viz., 3,5,7,11 where a reduction in sorption rate was registered at highly acidic and alkaline pH ranges being attributed to the protonation of the sorption sites and hydroxyl complex formation of the metal ion in solution respectively. The adsorption is found to be maximum at pH 5[11] for both the adsorbents and this pH is considered ideal for further experiments.

Conclusion

The experimental results have led to the conclusion that the treated tea dust and saw dust materials, have 97%

and 95% sorption efficiency towards Pb(II) ions under optimized operating factors viz., 0.30mm particle size, 100 mg dosage, 15/20 minutes agitation time, 10mg/L initial concentration of Lead (II) ions, pH 5 of the solution medium. It is concluded that the employment of tea dust and saw dust in the removal of lead (II) ions from aqueous solution has proved them to be promising adsorbent materials.

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ECONOMIC ASPECTS OF DOMESTIC WATER SUPPLY: A CASE STUDY FROM RURAL HOUSEHOLDS OF COIMBATORE DISTRICT IN TAMILNADU

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Abstract

Safe drinking water supply and basic sanitation are vital human needs for health and efficiency. Water needs are complexly linked with the daily life, especially of the poor communities. Through its widespread linkages, water plays an important role in the welfare societies. Census 2011 indicates that about 50 percent of the population and 45 percent of the habitations in India do not have access to safe drinking water. The Dublin statement (1992) puts the concept of water as an economic good on the global agenda. It states that "water has an economic value in all its competing uses and should be recognized as an economic good". In this backdrop this study analyse the economic aspects of domestic water supply from rural households of Coimbatore District in Tamilnadu. Coimbatore district in the state of Tamil Nadu has chosen for this study. This study used multistage sampling method was used to select sample villages. 342 sample households were selected across 4 taluks, 3 blocks, 4 village Panchayats and 31 habitations. This study finds that regression analysis of the factors that determine per capita consumption water (LPCD). The result shows that area, no. of year educated by female adult, consumption of water drinking – time, Sources for other purpose water do not significantly influence the per capita consumption of water at P > 0.05 level.

Keywords: *Consumption of water, Rural Water Supply*

Introduction

Water is the essential resource for life. It is also a scarce resource both in quantity and quality, and when available it is often of poor quality depending on location. Lack of potable water and basic sanitation services remains one of the world's most urgent health issues. It is estimated that 1.1 billion people in developing countries do not have access to safe drinking water and 2.6 billion people lack access to basic sanitation (UNDP, 2006; SIDA, 2004; UNICEF and WHO, 2005). In a broader sense, water resource management as a concept may outline a framework for numerous water related decisions. Given the fact that socio-economic development processes relate to the water resource, owing to interact with water and human activities. It is imperative to conceptualize the problem in hand with respect to economic, environmental and institutional aspects.

Economic Aspects

Recognizing the importance of water, the United Nations Water Conference says that a convenient supply of water is an essential ingredient of a healthy, productive life. Water, that is not safe for human consumption, can spread disease, and reduce the production time and energy of the water carrier. Coupled with malnutrition, the waterborne disease; take a dreadful toll in developing countries. For example in one Middle Eastern Country half of the children born alive die before reaching the age of five as a result of the combined effects of disease and malnutrition. In contrast, only two percentages of the children born in the UK die before reaching their fifth birthday. The conference asserts that it is invariably the poor who suffer the most from the absence of safe water.

Nature and the concept of water are changing rapidly over the years, from been treated as a public good with an economic good. United Nations (1997), the Global Water Conference concluded Earth Summit in Rio-de-Janerio (Agenda 21, chapter 18) endorsed the idea of treating water as an economic good concept of water necessitates fundamental alterations in the planning, designing, pricing and other policy framework, which requires, pricing policies to extract the scarcity rent from users, and the involvement of the community in the decision making process at all levels.

The Dublin statement (1992) puts the concept of water as an economic good on the global agenda. It states that "water has an economic value in all its competing uses and should be recognized as an economic good". Rogers, Bhatia and Huber (1998) bring out some modifications on Agenda 21 and the Dublin principles. This paper addresses the concept of water as an economic good and explains in practical terms economic tools that can be used to affect the environmentally, socially and economically efficient use of water.

Roath (1987) has developed a merit-good concept of water. The book states, 'safe drinking water is sometimes taken as a merit good in the sense that people who receive supplies of safe water benefit from it to a greater extent than they themselves believe'. Santhakumar (1998) has identified two sources of inefficiency in the provision of merit-good water. First is due to the fact that the State autonomously decides the nature and characteristics of the merit good. If the people does not prefer the nature of the good, or its consumption requires effort, these may lead to the non-consumption of the good.

The second source of inefficiency is in the selection of institutional framework.

The acquisition and free distribution of water from the state agency is inappropriate in efficiency solving the drinking water problem if different localities.

In this backdrop this study analyse the economic aspects of domestic water supply from rural households of Coimbatore District in Tamilnadu.

Materials and Methods

The study used primary data. The data were collected with the use of structured questionnaires. Coimbatore District in the state of Tamilnadu has been chosen for the study. 342 sample households were selected across 4 taluks, 3 blocks, 4 village Panchayats and 31 habitations. Multistage sampling method has used for this study viz., systematic, stratified proportionate random sampling methods to select the sample villages. Totally four villages were selected and grouped under four categories viz., Wet, Mixed (partially wet & partially dry), Dry (arid) and Hilly region. As per data classified the 'Anamalai' Block was chosen under Hill and Wet area categorization, where the villages viz., 'Nedungundra' was selected under Hill area category, where the Scheduled Tribes population is located, and, 'Subbegoundanpudur' was selected under Wet area. The 'Ambothi' Village in 'Annur' Block has acute dry nature; hence the Village was selected under Dry area. In the Mixed area (partially wet and partially dry) classification 'Thondamuthur' block was chosen in which 'Madampatti' village was selected as Study area Of the total households, in the four selected villages, 10 per cent of the sample households were chosen proportionately.

Table 1 Area wise Consumption of Water

Area	Statistics	Consumption of water per day (in litres)													
		Drinking	Cooking	Bathing	Washing utensils	Washing clothes	Cleaning House	Sprinkling at entrance	Livestock purpose	Gardening	Vehicles	Total Consumption	LPCD	Total consumption (According to NORMS)	LPCD (According to NORMS)
Wet	Sum	1005	2616	10782	3699	3407	431.36	2664	504	338.1429	15.42	29502.92	7295.786	22574.36	5521.218
	Mean	11.04	28.75	118.48	40.65	37.44	4.74	29.27	5.54	3.72	0.17	324.21	80.17	248.07	60.67
	S.D.	3.97	7.86	46.25	10.42	29.24	3.43	8.72	24.69	10.77	1.14	95.90	17.89	74.50	10.24
Mixed	Sum	1199	3133	13545	4356	4884.75	347.03	2272	1278	102.84	159.37	35911.99	8525.002	27215.03	6434.449
	Mean	10.52	27.48	118.82	38.21	42.85	3.04	19.93	11.21	0.90	1.40	315.02	74.78	238.73	56.44
	S.D.	3.62	7.39	55.05	13.09	25.01	3.51	7.02	35.31	3.92	3.26	117.65	18.18	85.42	11.63
Dry	Sum	940	1868	7179.75	2243	3129.75	69.83	852	1512	0	23.13	20481.46	4516.209	14964.58	3291.089
	Mean	9.22	18.31	70.39	21.99	30.68	0.68	8.35	14.82	0.00	0.23	200.80	44.28	146.71	32.27
	S.D.	3.59	7.97	64.37	12.48	20.22	1.57	7.22	42.79	0.00	1.15	147.06	24.97	101.67	16.82
Hilly	Sum	367	1098	4662	2070	2268	0	0	144	0	0	12553	3322.667	10141	2680.517
	Mean	10.49	31.37	133.20	59.14	64.80	0.00	0.00	4.11	0.00	0.00	358.66	94.93	289.74	76.59
	S.D.	3.01	6.44	38.36	11.19	21.28	0.00	0.00	16.96	0.00	0.00	78.89	15.24	63.45	11.27
Total	Sum	3511	8715	36168.75	12368	13689.5	848.22	5788	3438	440.9829	197.92	98449.37	23659.66	74894.97	17927.27
	Mean	10.27	25.48	105.76	36.16	40.03	2.48	16.92	10.05	1.29	0.58	287.86	69.18	218.99	52.42
	S.D.	3.71	8.97	59.11	16.28	26.32	3.31	12.12	34.08	6.16	2.14	131.99	26.42	98.88	19.34

The Department of Drinking Water Supply (DDWS), Ministry of Rural Development, has set itself the goal of providing safe and adequate water for drinking, cooking and other domestic needs on a sustainable basis to every rural person. This table reveals the average consumption of water per household in the study area. Actually, the government norms allotted per individual per day utility of water is 40 litres. It incorporates drinking, cooking, bathing, washing utensils, house cleaning and ablution per day for every individual. The table expresses the consumption of water collectively at household level and corresponding LPCD. In wet area average litres of water consumed for drinking is only 11.04 litres. Among the all domestic consumption bathing need more quantity of water which is 118.48 litres followed by washing utensils nearly 41 litres. It is clearly seen in the table that there is inflated water usage in bathing than to other domestic usages, even washing of clothes do have less consumption of water for wet area has the circumference of river water and this source point is utilized for washing. Therefore, the utilization of water in source point cannot be calculated for it is floating water and not used in domestic supply. Hence, the usage of domestic water towards expending against bathing is diminished. Owing to awareness of the people they are not using river water for drinking. Consequently utilization of domestic water towards washing the clothes has been cut back by the villagers. Normally the actual LPCD is around 80 litres per individual. Which shows the government norms of 40 litres LPCD has been surpassed due to the reason that availability of water since is wet area.

The supply of actual water according to government norms is nearly 61 litres. The average domestic consumption of water in mixed area is 315 litres per household. LPCD is comparatively higher than dry area and lower than wet and hilly areas. Irrigation well has the great consequence of water usage pattern since washing of clothes is done in this source and hence bathing average percentage reflects higher than other domestic usage which is 118.82 litres. The given supply according to the norms in wet areas of LPCD is 75 litres. Another usage that draws importance is maintenance or cleaning of vehicles need 1.4 litres of water which is hardly reflected as a major usage in other areas as reflected in mixed areas. The average family size in a dry area is 4.49 persons but the supply according to norms of LPCD is only 32 litres. That supply even is amalgamation of government source and private sources of distribution. There is a vast difference in water consumption pattern lies naturally in this area due to acute dryness compared to other areas. Relatively, bathing (70.39 litres) takes less quantity of consumption of water than other areas for school children even take a bath once in two days and others take a bath once in four days which shows the pathetic condition of the area. Working population retrenched their usage of water towards bathing; even with the sweat they are saving water for their children who are going to school. Considerably, the supply of LPCD through government sources is insufficient and not satisfactory. Hence, people have to immensely depend on private sources which are also limited. It is clearly visible from the table meagre quantity of water has been used for cleaning houses sprinkling. Augmenting the supply of water towards government distribution system resembles stochastic hence the dependence on available next best possible opportunistic private sources which is also rarely available.

Yet, another area which has a surplus quantity of water, which is neither a government source nor a private source. This special feature of traditional source in hilly region enjoys extravagantly availability of water. Utilize water from the springs as it is the available source to them. There is hardly any possibility to supply water by constructing OHT or any other distribution system. Local Panchayat has constructed a water tank which stores water and pipeline has been laid for the supply for the source point, springs through gravity. It would be hard to accept that there are no stand posts or any other distribution system but the pipeline as such has huge open with closet, where in necessarily requirements are being availed from it. Though the average consumption of water for cleaning house, sprinkling, gardening and vehicle maintenance is zero litre. Total household utilization rises up to around 359 litres. The LPCD is in actual need of nearly 95 litres. Naturally, consumption of water is directly proportionate with the availability of water and vice versa, hence it is incidentally visible in hilly and wet areas. One of the major components in a hilly area is that springs as water source completely fulfills the need of the tribal population.

Overall the table reveals the consumption of water against various area classifications, its relevance with various domestic usage patterns, LPCD according to norms and its actual need of the population. Also, it is to be considered, exclusive of hilly area all other areas are lacking from modern source such as house service connection and stand post for their cooking and drinking purposes. Thus domestic water supply provided by the government

distribution system in accordance with the domestic usage such as bathing, drinking, washing, cleaning utensils etc., is definitely insufficient and not satisfactory, hence it is estimated and calculated that additional 30 litres of LPCD with the existing norms irrespective of the land towards domestic usages should be augmented by the public purse.

Hypothesis

The family size, landholding, family income, female education, area (wet, mixed, dry and hilly), expenditure, water distribution time for drinking and cooking water, distance and time spent for water collection are the key determinants of consumption of water.

At the household level seventeen variables have been identified, which include area (dummy variable 1. Wet, 2. Mixed, 3. Dry, 4. Hilly), family size, total land, wetland, dry land, no. Of year female education, total family income, total expenditure per month, total time spent for water collection, the total distance for water collection, sources for drinking and cooking water, consumption of water for drinking – time, consumption of water for another purpose – time, sources for other purpose water, age of water collector, water collection (1. Male, 2. Female, 3. All family members). Correlation matrices were applied to understand and shortlist the number of variables, which influence the per capita water consumption at the household level. Of the seventeen variables area, family size, dry land, no. Of year female education, total family income, total expenditure per month, total distance for water collection, sources for drinking and cooking water, consumption of water for drinking – time, consumption of water for other purpose – time, sources for other purposes water, age of water collector, water collector for consumption of water were consider for running the regression against per capita consumption of water at households these variables exhibit a high percentage of correlation.

Table 2 Regression results – Consumption of Water (LPCD)

S.No.	Independent Variables	Regression Co-efficient	Std. Error	't' Value	Sig.
1	Constant	98.224	5.236	18.758	.000
2	X_1	-2.495	1.317	-1.894	.059
3	X_2	-9.309	.865	-10.763	.000
4	X_3	.178	.169	1.055	.292
5	X_4	.001	.000	3.141	.002
6	X_5	.002	.001	1.777	.077
7	X_6	-.011	.003	-3.583	.000
8	X_7	6.969	1.191	5.853	.000
9	X_8	-.668	1.238	-.539	.590
10	X_9	-.14.280	1.724	-8.284	.000
11	X_{10}	.722	.408	1.770	.078
12	X_{11}	.085	.037	2.307	.022
N = 342, **R** = .765, **R^2** = .59 Significant at 5% level					

Functions: Y = a ± bx

$Y = 98.224 - .2.495_{(Area)} - 9.309_{(FS)} + .178_{(NYEFA)} + .001_{(TMFI)} + .002_{(TEM)} - .011_{(TDWC)} + 6.969_{(SDWCW)} - 668_{(CWDT)} - 14.280_{(DTOPW)} + .722_{(SOPW)} + .085_{(AWC)} + Error$

Where Y = Per Capita Consumption of Domestic Water (LPCD)

a = Constants

X_1 **=** Area (1. Wet, 2.Mixed, 3.Dry, 4.Hilly)

X_2 = Family Size (FS)

X_3 = No. of year educated by female adult (NYEFA)

X_4 = Total Monthly Family Income (TMFC)

X_5 **=** Total Expenditure per Month (TEM)

X_6 = Total Distance for Water Collection (TDWC)

X_7 = Sources for Drinking and Cooking Water (SDWCW) (1.HSC, 2.Stand Post, 3.OHT (on spot) 4.Spring, 5. Own Agricultural well)

X_8 = Distribution Time for Drinking and Cooking water (CWDT) (1.Per day, 2.Two days once, 3.Four days once, 4.Weekly once)

X_9 = Distribution Time for Other Purposes Water (DTOPW) (1.Per day, 2.Two days once, 3.Three days once, 4.Four days once, 5.Weekly once)

X_{10} = Sources for Other Purpose Water (SOPW) (1.HSC, 2.Stand post, 3.Hand Pump, 4.Both HP & SP, 5.HSC & HP, 6.SP & Near Irrigation well, 7.Spring, 8.Irrigation bore/well, 9.River)

X_{11} = Age of Water Collector (AWC)

μ = Error term

Table presents the regression analysis of the factors that determine per capita consumption water (LPCD). The result shows that area, no. of year educated by female adult, consumption of water drinking – time, Sources for other purpose water do not significantly influence the per capita consumption of water at P > 0.05 level. However Family size, dry land, total family income, total expenditure per month, the total distance for water collection, sources for drinking and cooking water, consumption of water for another purpose – time, age of water collector, water collector for consumption of water are per capita consumption of water are statistically significant at P > 0.05 level. The R square value turns on to be 0.60. This shows that 60 percent of the variations are explained by the variations in the independent variables. No. of year educated by female adult, Sources for other purposes water is positively related to Family size, dry land, total family income, total expenditure per month, the total distance for water collection, sources for drinking and cooking water, consumption of water for another purpose – time, age of water collector, water collector for consumption of water are per capita consumption of water for an average consumption of water. This indicates that No. of year educated by female adult, sources for other purposes water is increasing the average consumption of water by households will also increase.

To understand the implications of the results a detailed discussion is necessary. In the area, as indicated in the methodology, four categories were made, such as wet, mixed, dry and hilly region. The negative value of the coefficient was found with area factor. This implies that per capita consumption goes on declining in wet, mixed, dry and hilly region. This negative trend is due to high levels of per capita consumption in hill area, slightly lower in wet and mixed area, further low level in dry area. The secondary source of information for the TWAD Board also supported this view. All the regions people are using more modern sources as a principal source for both drinking and cooking purposes like stand, house service connection. Another crucial factor, which is inversely related to water consumption, was the family size. As family size increases the resultant total consumption goes up but the per capita consumption comes down. This is due to water requirement for other domestic uses, which does not vary regardless of the number of persons in a household. For instance, water used for cooking, house cleaning, upkeep of livestock, washing clothes and bathing may not increase commensurately with the increase in family size.

Conclusion

To conclude, India has the largest rural drinking water supply programme in the world, serving close to 1.5 million habitations and 742 million people. The status of the provision of drinking water at the national, state and district levels has been unsatisfactory. On an average twenty five percentage of the rural habitations of Tamilnadu remain uncovered. Even where provided, the problem of Operation & Maintenance continued to persist. This study confirms that the implementation of water provision schemes is skewed towards wet and mixed villages, while arid village have received very less attention. The consumption of water against various area classifications, its relevance with various domestic usage patterns, LPCD according to norms and its actual need of the population. Also, it is to be considered, exclusive of hilly area all other areas are lacking from modern source such as house service connection and stand post for their cooking and drinking purposes. Thus domestic water supply provided by the government distribution system in accordance with the domestic usage such as bathing, drinking, washing, cleaning utensils etc., is definitely insufficient and not satisfactory, hence it is estimated and calculated that additional 30 litres of LPCD with the existing norms irrespective of the land towards domestic usages should be augmented by the public purse.

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WATER MANAGEMENT-THE NEED OF THE HOUR

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Abstract

Water management plays a major role where it focuses on the use of sustainable resources. As it is a integral part of our life it gives importance to Drinking, washing and cleaning, biodiversity, agriculture etc. Growing pollution of water sources is affecting the availability of safe water besides causing environmental and health hazards. Growing pollution of water sources is affecting the availability of safe water besides causing environmental and health hazards. making is crucial to the objectives of equity, social justice and sustainability. Good governance through informed decision. Planning, development and management of water resources need to be governed by national perspectives on an integrated and environmentally sound basis, keeping in view the human, social and economic needs.

Keywords: *Water management, Use of water in our daily basis, Need of water, Programs introduced for water management*

Introduction

" A drop of water is worth more than a sack of gold to a thirsty man"

Water management means dealing with water in the best possible way. This can be done by local authorities (municipal water management) or it can be done by individuals at home (when we manage how we use our own water supplies). Good water management also ensures sufficient usage of water for the present as well as future generation. In simple words, water management emphasis on the role of sustainable usage of resources.

Uses of Water in Our Daily Life

Water is an integral part of human life. Without water life on earth is not possible for all living organisms. Therefore it is indeed essential to know the importance of water to carry out our daily activities.

1. **Drinking Water**

   Human beings need to drink around eight glasses of water a day in order to get sufficient hydration. This shows how water plays an eminent role in the life of an individual.

2. **Washing and Cleaning**

   We also use water to keep ourselves, our clothes and our homes clean and hygienic. From washing our hands before a meal to deep cleaning of a hospital floor, we need clean water for almost all aspects of good hygiene.

3. **Agriculture**

   Water is used throughout the world to grow crops such as grains and fruits. A good water supply is needed to prevent hunger and famine.

4. **Leisure and fun**

   Swimming, boating and many other leisure activities involve water. Swimming pool water needs to be managed by treating it with chlorine and regularly testing its levels of bacteria and other substances, to ensure that it is safe for people to swim in.

5. **Biodiversity**

   Water resources are habitats for a wide range of birds, mammals, fish, reptiles and amphibians as well as for water dwelling plants. Therefore water resources like lakes, rivers, spring water etc. need to be conserved to enhance biodiversity.

Methods of Water Management

There are many ways to conserve water. As water is the most efficient source for the survival of every individual, plants and animals. Few Methods were adopted for managing water issues. Following are the five main key methods for water management.

1. **Treatment of Wastewater**

   Treatment of wastewater very often involve recycling water and treating it, so that it is safe to be piped back into people's homes and used for drinking, washing and so on. This method is very essential

because it ensures an efficient usage of resources and there by conserving the water resource.

2. **Irrigation systems**

Irrigation systems can be deployed to nourish crops in drought hit areas. Agricultural sector in our country is dependent on irrigational facilities due to failure of monsoons. In India, even now, the traditional techniques of flood irrigation are followed which involve flooding of field with water. Such techniques involve ample wastage of water. Modern irrigation techniques like drip irrigation, sprinkler irrigation are found to be more efficient one where wastage of water is minimum. It is also found that the modern irrigation practices increases the productivity of agricultural land.

3. **Conserving water**

Each and every individual can conserve many gallons of water every day, simply by not running taps or using water-guzzling appliances unnecessarily. Water can also be conserved by generally consuming less. Not many people realize how much water goes in to the production of a car or an item of clothing. Cutting down on the amount of things that we buy can really reduce the amount of water that is needed to support our lifestyle.

4. **Caring for the natural water supplies**

Natural water sources such as lakes, rivers and seas are so important. Both fresh water ecosystems and marine ecosystems are home to a wide variety of different organisms and without the support of these ecosystems, these organisms would most likely become extinct. Thus the main motto of good water management is, not to pollute the natural resources and to safeguard them.

5. **Effective implementation of plans**

There is no denying that easy access to fresh, clean, safe water is a right that all humans should enjoy. However, in many parts of the world, people have to walk many miles in order to access clean water. So, good water management systems are only truly praiseworthy if they are implemented throughout the world so that everyone can benefit from them. Good water management means, not just a convenient and safe water supply for some people, but water for everyone to use. The role of public sector is pivotal in implementing effective plans, because as modern economic theory says, government plays an effective role in ensuring the welfare of the state.

Water Management in India

India has more than 17 percent of the world's population, but has only 4 percent of world's renewable water resources with 2.6 percent of world's land area. The total surface flow, including regenerating flow from groundwater and the flow from neighboring countries, is estimated at 1,869 cubic kilometers per year (km3/year), of which only 690 km3 are considered as utilizable in view of the constraints of the present technology for water storage and inter-state issues. The Central Water Commission estimates the groundwater resources at 418.5 km3/year. Part of this amount, estimated at 380 km3/year, constitutes the base flow of the rivers. The total renewable water resources of India are therefore estimated at 1,907.8 km3/year.Though it is a natural resource we are in a situation where we have to pay for water and then consume it. In India states like Punjab, Tamil Nadu and Haryana there is water dispute issues. If these issues are not resolved it will definitely affect the livelihood of people.

Need to Conserve Water

1. Rapid growth in demand for water due to population growth, urbanization and changing lifestyle pose serious challenges to water security because in large parts of India water is been stressed.
2. There is wide variation in availability of water, which may increase substantially due to climate changes, causing more water crisis and incidences of water related disasters, i.e., floods, increased erosion and increased frequency of droughts, etc.
3. Climate change may also increase the sea levels. This may lead to salinity intrusion in ground water aquifers / surface waters and increased coastal inundation in coastal regions.
4. Access to safe drinking water still continues to be a problem in some areas. Skewed availability of water between different regions and different people in the same regions has the potential of causing social unrest.
5. Groundwater, a community resource, is still perceived as an individual property and is exploited inequitably and without any consideration to its sustainability leading to its over-exploitation in several areas.

6. The existing water resources infrastructure is not being maintained properly resulting in under-utilization of available resources
7. Growing pollution of water sources is affecting the availability of safe water besides causing environmental and health hazards
8. A holistic and inter-disciplinary approach at water related problems is missing.

General Measures for Water Management

There are few hygienic measures for management of water.

- Planning, development and management of water resources need to be governed by national perspectives on an integrated and environmentally sound basis, keeping in view the human, social and economic needs.
- Large water supply schemes to meet the urban as well as rural needs of water for both irrigation and drinking, and piped water supply schemes for drinking water.
- making is crucial to the objectives of equity, social justice and sustainability. Good governance through informed decision
- Access to safe and clean drinking water and sanitation should be regarded as a right to life essential to the full enjoyment of life and all other human rights. As such, water for such human needs should have a pre-emptive priority over all other uses.
- Rain water harvesting and artificial recharge of ground water sources.
- Treatment of chemically and biologically contaminated ground water sources in rural areas for provision of safe potable water.
- Augmentation of water resources in coastal areas by large scale desalination of abundant sea water.
- Treatment of domestic/industrial effluents and recycling of usable water for irrigation and commercial purposes thereby diverting the water used in these areas for domestic consumption

Measures of Water Management With Respect to India

The second largest consumer of water in India is industrial sector which pollutes more water than what it utilizes. Entire stretch of major rivers including Ganga is polluted due to sewage and industrial waste discharge. Every year government releases millions of Rupee for the cleaning of rivers but the water resource is getting more polluted every day because of industrial discharge and corruption. Wasteful use of water is witnessed in domestic sector also. Therefore following norms has been suggested to conserve water resources in India.

The proper water management involves judicious use of water along with its conservation. The motto of water management is to make the water availability perpetual one. For that matter rain water harvesting is most promising tool. It must be made compulsory for all new building and the government buildings. Government provides subsidy to the farmers for purchasing tube wells. The excessive use of tube wells is leading to fast depletion of ground water. At least in urban areas government may impose an extra levy on extracting ground water. Declining ground water levels in over-exploited areas need to be arrested by introducing improved technologies of water use, incentivizing efficient water use and encouraging community based management of aquifers. In addition, where necessary, artificial recharging projects should be undertaken so that extraction is less than the recharge. This would allow the aquifers to provide base flows to the surface system, and maintain ecology.

There should be a forum at the national level to deliberate upon issues relating to water and evolve consensus, co-operation and reconciliation amongst party States. A similar mechanism should be established within each State to amicably resolve differences in competing demands for water amongst different users of water, as also between different parts of the State.

And last but not the least, to meet the need of the skilled manpower in the water sector, regular training and academic courses in water management should be promoted. These training and academic institutions be regularly updated by developing infrastructure and promoting applied research, which would help to improve the current procedures of analysis and informed decision making in the line departments and by the community.

Low public consciousness about the overall scarcity and economic value of water results in its wastage and inefficient use. Therefore a general awareness about water management is needed to be created and the community must proactively involve itself in the conservation of most vital resource of earth for its sustainable development.

Programs Introduced for Water Management in India

- Rooftop rainwater harvesting systems,
- Storage tanks, bio-sand filters,
- Stand posts with water taps in schools and homes provide water for drinking and sanitation—
- Groundwater levels are augmented with check dams,
- Contour trenches,
- Dug well recharging, pressurized recharge wells,
- Pond development;
- Community soak wells and pits ensure safe wastewater disposal.
- Villagers and development committees are being trained to effectively manage water resources,
- Water literacy sessions motivate villagers to conserve water.

Conclusion

Water is a vital element for life. All our human activities depend on water. Once water was considered as "Free good" in economics as it was available in abundance. But over the decades many economists considered water as an "Economic good" the reason behind this is very simple. We human beings have exploited or over used the water resources to a greater extent; as a result of which we are facing water scarcity. Therefore it is very necessary to conserve our water resources and ensure an efficient usage of it.

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ANALYSIS OF GROUND WATER IN TAMILNADU

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Abstract

World's most precious resource is becoming increasingly scarce for too much of the population, 60 per cent of humanity lives in areas of water stress, where the supply of water cannot or will not continue to meet demand. India receives annual precipitation (including snowfall) of about 4000 km^3. It is estimated that out of the 4000 km3 of the country, 1869 km^3 is average annual potential flow in rivers available as water resources. Out of this only 1121 km^3 is only utilizable (690 km^3 from Surface Water and 433 km^3 from Ground Water). India is suffering from the worst water crisis in its history and millions of lives and livelihoods are under threat. Currently, 600 million Indians face high to extreme water stress and about two lakh people die every year due to inadequate access to safe water. The crisis is only going to get worse. Tamil Nadu constitutes 4 per cent of India's land area and is inhabited by 6 per cent of India's population, but has only 2.5 per cent of India's water resources. The demand for water in Tamil Nadu is increasing at a fast rate both due to increasing population and also due to larger per capita needs triggered by economic growth. In this background the study to analyze based on secondary sources from various reports with using appropriate statistical tools. The threat to water resources has brought into focus the urgent need for planned action to manage water resources effectively.

Keywords: *Water demand, Ground Water Availability.*

Introduction

In a startling reminder that our world's most precious resource is becoming increasingly scarce for too much of the population, Cape Town (South Africa) hit the headlines for declaring a date for Day Zero: the day on which city taps run dry. But long queues and limited water supplies are already happening in many other less headline-worthy locales, reminding us of the need for better and fairer management of Earth's water supply. Already more than 60 per cent of humanity lives in areas of water stress, where the supply of water cannot or will not continue to meet demand. If water is not managed more prudently – from source, to tap, and back to source – the crises observed today will become the catastrophes of tomorrow. This year's The State of the World's Water reveals that the number of people defined as without clean water close to home has gone up, with new entries in our ranking. Some 844 million people are now struggling to access life's most essential requirement – almost 200 million more than previously counted. Now record both what source people obtain their water from and how far they travel for it. Anything longer than a 30-minute round trip no longer counts as access. As a result, countries including Uganda and Niger are now counted among those with the lowest rates of access; many countries also face intense competition with agriculture and industry for water, and ever-growing challenges from extreme weather, political instability, conflict and displacement. New data that links water access to household wealth also shows that, even in countries making progress, there are still vast discrepancies between richest and poorest.

Table 1 The Top Five Countries with Lowest Access to Clean Water Close to Home – by Population

Rank	Country	Number of People without Clean Water in Per Cent
1	India	44
2	Ethiopia	17
3	Nigeria	16
4	China	16
5	Indonesia	7

Source: The water gap – The State of the World's Water 2018, www.wateraid.org

From the above table -1, top of this list once again is India. It is also one of the world's most-improved nations for reaching the most people with clean water, but faces challenges with falling groundwater levels, drought, demand from agriculture and industry, pollution and poor water resource management – challenges that will

intensify as climate change contributes to more extreme weather shocks.

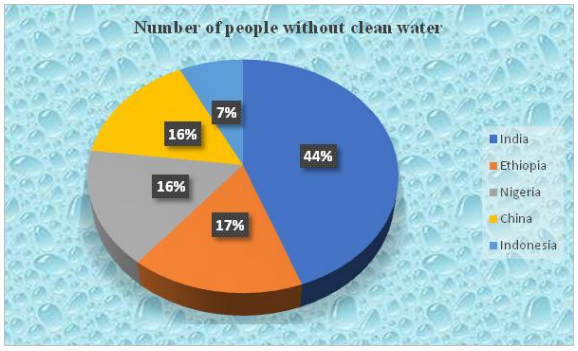

Figure - 1

Water Resources of India

On an average, India receives annual precipitation (including snowfall) of about 4000 km3. However, there exist considerable spatial and temporal variations in the distribution of rainfall and hence availability in time and space across country. It is estimated that out of the 4000 km3 of the country, 1869 km^3 is average annual potential flow in rivers available as water resources. Out of this only 1121 km^3 is only utilizable (690 km^3 from Surface Water and 433 km^3 from Ground Water) The basic facts regarding water availability in India is presented in table 2 below.

Table 2 Details of water resourses in india

S.No	Water resources at a glance	Quantity(km^3)	Per cent
1	Annual precipitation (including snowfall)	4000	100
2	Percipitation during monsoon	3000	75
3	Evaporation+Soil water	2131	53.3
4	Average annual potential flow in rivers	1869	46.7
5	Estimated utilizable water	1123	28
	Surface water	690	17.3
	Replenishable groundwater	433	10.8
	Current utilization of Annual precipitation	634	15.85

Source: India-wris.vrsc.gov.in (2011)

Statement of the Problem

Tamil Nadu constitutes 4 per cent of India's land area and is inhabited by 6 per cent of India's population, but has only 2.5 per cent of India's water resources. More than 95 per cent of the surface water and 80 per cent of the ground water have already been put into use. Major uses of water include human/animal consumption, irrigation and industrial use. The demand for water in Tamil Nadu is increasing at a fast rate both due to increasing population and also due to larger per capita needs triggered by economic growth. The per capita availability of water resources however, is just 900 cubic meters when compared to the national average of 2,200 cubic meters. Agriculture is the largest consumer of water in the State using 75 per cent of the State's water resources. Demands from other sectors such as domestic and industries have been growing significantly.

Review of Literature

Rohini Nilekani ,(2015) examined that India understands that we have a serious water crisis. Too many of our rivers are polluted, dammed, or dying. Rainfall is becoming increasingly erratic, and expected to become more so. Groundwater is depleting fast and lakes are drying up or filling with sewage, especially in urban centers. Water and sanitation infrastructure is old and creaking in many places and does not even exist in others. Agriculture, industry and urban settlements all compete for the same scarce re source. **Shashank Shekar et al., (2015).** examined the marginally saline and saline groundwater resource potential is mostly restricted to shallow water level areas underlain by older alluvium. The quality of ground water should be a major consideration before augmenting the drinking water needs by ground water resource. **Jethoo and Poonia (2011)** examined the different income group consumer's behavior with respect to the dwindling water supply in Rajasthan. The study It was observed that in ignorance of depleting water tables and acute shortage of drinking water due to little awareness, people were using much more water than it was needed. The study also addressed immediately by changing public perception towards water use through media and by organizing public awareness programes. **Angappapillai and Muthukumaran (2012) examine** fast-growing population has results in the fast urbanization and increasing demand for water from various sectors of the state economy. This requires an understanding from various sources of water supply and the demand arising from various sectors for water availability. The present paper attempts to provide a description of the demand and supply of water in the state of TamilNadu called out from various sources.

Background of the Study

India is suffering from the worst water crisis in its history and millions of lives and livelihoods are under threat. Currently, 600 million Indians face high to extreme water stress and about two lakh people die every year due to inadequate access to safe water. The crisis is only going to get worse. By 2030, the country's water demand is projected to be twice the available supply, implying severe water scarcity for hundreds of millions of people and an eventual 6per cent loss in the country's GDP. As per the report of National Commission for Integrated Water Resource Development of (Ministry of Water Resources,2017), the water requirement by 2050 in high use scenario is likely to be a milder 1,180 BCM, whereas the present-day availability is 695 BCM. The total availability of water possible in country is still lower than this projected demand, at 1,137 BCM. Thus, there is an imminent need to deepen our understanding of our water resources and usage and put in place interventions that make our water use efficient and sustainable. In this background the study was analysed the urban water demand and supply in TamilNau with the following specific objectives.

- To examine water demand and supply in Tamil Nadu.
- To analyze the Ground Water availability in TamilNadu.

Methodology

The State is heavily dependent on monsoon rains. The annual average rainfall is around 930 mm (47 per cent during the north east monsoon, 35 per cent during the south west monsoon, 14 per cent in the summer and 4 per cent in the winter). Actual rainfall for the year 2010-11 is 1165.10 mm, out of which 48 per cent is through the north east monsoon, 32 per cent is through the south west monsoon and the remaining 20 per cent is through summer and winter rainfall. Since the State is entirely dependent on rains for recharging its water resources, monsoon failures lead to acute water scarcity and severe droughts. In this background, the study is based on secondary data, the data is include National, State and District level data on water resource availability and utilization, Ground water data are collected from Central Ground Water Board and Various Government reports. Statistical tools like Regression, Descriptive analysis, were used to achieve stipulated objectives. The study period we are analyze for the water year census 2011.

Limitations of the Study

- It is a macro level study. Thus, the findings of the study may not be applicable to the micro level.
- The study has used the data on water availability and other related variables are collected from Central water commission, Central Ground Water Board and Ministry of water resources (2011), Tamil Nadu Water and Drainage Board.(2017)
- If monthly or annually data have been available the results might have been different.

Water Availability in Tamil Nadu

In Tamil Nadu more than 90 per cent of the available surface water and 45 per cent of the ground water has been utilized. But the demand for water is continuously on the rise with the growth of population, and increasing growth in Industrial and Agricultural sectors. But the availability of water remains constant. Under the above circumstances the present trend of consumption would not be sustainable. Hence, there must be a judicious mix of using not only the available water resources namely surface water and ground water, but also to use recycled waste water. In addition, conservation of available water resources and harvesting rain water can sustain us from a potential water crisis.

Surface Water

Surface Water Tamil Nadu has 17 major river basins with a surface water potential of 853 Thousand Million Cubic feet (TMC). More than 90per cent of the surface water has already been utilized. The State has initiated several schemes in the Twelfth Five-year Plan for interlinking of rivers in the State. This allows for equitable distribution of water. There are 79 reservoirs having a total storage capacity of 243 TMC. These are essentially irrigation reservoirs. It has been estimated that an average of 177 TMC water flows into the sea as surplus in the years of more than average rainfall. The State is constructing check dams to arrest runoff and attempt storage of water for beneficial use.

Table 3 Basin Wise Surface Water Potential in Tamil Nadu

S.No	Basin/Basin Group	Surface water potential	
	Particulars	In MCM	In TMC
1	Chennai	1645	58.09
2	Palar	1264	44.64
3	Varahanadhi	429	15.15

4	Pennaiyar	1396	49.3
5	Paravanar	379	13.38
6	Vellar	985	34.79
7	Cauvery	5805	205
8	Agniyar	1136	40.12
9	Pambar &Kottakaraiyar	648	22.88
10	Vaigai	1372	48.42
11	Gundar	549	19.39
12	Vaippar	715	25.25
13	Kallar	28	4.52
14	Tamiraparani	1374	48.49
15	Nambiyar	203	7.17
16	Kodaiyar	916	32.35
17	PAP	675	23.84
	Total	**19619**	**692.78**

Source: TamilNadu state action plan for climate change, 2011.

River basins of Tamil Nadu and Water Potential

There are 17 river basins in Tamil Nadu. Cauvery is the only major basin. Of the others, 13 basins are medium and 3 are minor river basins. At 75 per cent dependability, the annual surface water generated in the State is 692.78 TMC (19,619 MCM). Table 3 detailing the surface water potential in the different districts of Tamil Nadu.

The State depends on neighboring States for considerable quantum of flows, which is about 261.70 TMC (7411 MCM) annually. Table 4 indicates the water received from the States of Andhra Pradesh, Karnataka, Kerala and Maharashtra. Thus, the total surface water potential of the State at 75 per cent dependability is 954.58 TMC (27,030 MCM)

Table 4 Surface Water Contribution Expected from Neighbouring States

S. No	State	River	In MCM	In TMC
1	Andhra Pradesh	Araniar	28.32	1
		Kosathalayar	14.16	0.5
		Krishna	113.28	4
		Palar	62.3	2.2
		Sub Total	**218.06**	**7.7**
2	Karnataka	Pennaiyar	169.9	6
		Krishna	113.28	4
		Cauvery	5436.86	192
		Sub Total	**5720.04**	**202**
3	Kerala	Periyar	622.96	22
		Shengagavalli	56.63	2
		Bhavani	764.55	27
		Amaravathy	141.58	5
		Neyyar	84.95	3
		Sub Total	**1670.67**	**59**
4	Maharashtra	Krishna	113.28	4

Source: TamilNadu state action plan for climate change, 2011.

Groundwater Availability in Tamilnadu

Tamil Nadu State is underlain by diverse hydro geological formations, nearly 73 per cent of the state is occupied by hard rocks, the semi-consolidated and consolidated formations are mainly confined in the eastern part including the coastal tract. In the hard rock area, groundwater is mainly developed through dug wells and degum bore wells tapping the weathered zone, the yield of open wells varies from 1 to 3 litre per scale(lps), whereas in dug wells tapping soft rocks including sedimentary formations, the yield is up to 10 lps. The dynamic groundwater sources have been assessed firka wise. The Annual Replenishable Groundwater resource of the State has been estimated as 21.53 bcm and Net Annual Ground Water Availability is 19.38 bcm. The Annual Ground Water Draft is 14.93 bcm and Stage of Groundwater Development is 77 per cent. The groundwater water draft is 14.93 bcm which is 10 per cent lesser than 2009 estimate. The overall stage of groundwater development of the state is 77 per cent This is attributed to reduction in irrigation draft due to urbanization is some regions of the state and marginal reduction in usage of dug wells for domestic use, (Dynamic Groundwater Resources of India as on 2017).

The dynamic groundwater resources are also known as annual replenishable groundwater resources since it gets replenished / recharge every year. The annual replenishable groundwater resources for the entire state has been assessed as billons cubic meter (bcm). The major source of groundwater recharge is the monsoon rainfall. The overall contribution of rainfall to countries annual replenshiable groundwater resources is 21.53 bcm. District-wise groundwater resources of India as on march 2011 is given in the table 8 above Presents the overall scenario of groundwater resources utilization and availability of the state, (CGWB Annual report 2015-2016)

Table 5 Discriptive Analysis of Groundwater Availability in Tamilnadu

S.No.	Particulars	Mean	Median	Std.Deviation
1	Annual replenishable ground water resource	6.73	5.89	40758.70
2	Net Groundwater availability	5.97	5.30	37734.506
3	Annual Groundwater draft	4.67	4.56	33036.896

4	Projected demand for Domestic and Industrial uses upto 2025	5681.44	2748.50	10143.559
5	Groundwater availability for future irrigation	1.37	7035.50	28635.220

Source: Estimation based on CGWB(2011).

The above Table 5 Descriptive analysis is the projected demand for domestic and industrial use upto 2025 was 5681.44 is the maximum value in TamilNadu level and 1.37 is the minimum value in descriptive analysis. The Standered deviation of the estimated higher value in all over TamilNadu was 40758.70 and lowest value was 10143.559.

Table 6
Regression Analysis of Groundwater Availability in Tamilnadu

S. No.	Particulars	Beta Value	Standered error	t-Value	Significant
1	Population		**384662.931**	**5.123**	**.000***
2	Annual Groundwater Draft	.084	7.732	.349	**.729***
3	Net Groundwater availability	1.715	38.549	1.250	**.222***
4	Annual Replenshiable Groundwater	-1.553	35.523	-1.137	**.265***
5	R^2	.099			
6	A R^2	.002			
7	F Value	1.024			
8	Significant	.397*			

Source: Estimation based on CGWB(2011).

Regression Analysis had been used for understanding the availability of groundwater in TamilNadu. The result was being discussed under the table 6. Dependent variable for the analysis was population was 384662.931 and the annual groundwater draft was 7.732 and net groundwater availability was 38.549 and annual replenshiable groundwater is 35.523 R^2 is .099 and Value of F was 1.024 was significant at all selected variables together were significant to affect the total population in India.

Table 7 Regression Analysis of Groundwater Availability for Future Irrigation in Tamilnadu

S. No.	Particulars	Beta Value	Standered error	t-Value	Significant
	Population		361079.92	5.121	**.000***
1	Net Groundwater availability	.193	6.421	.844	**.405***
2	Groundwater availability for future irrigation	-.078	7.828	-.369	**.715***
3	Projected Demand For Groundwater	.205	20.757	1.030	**.312***
4	**R^2**	.100			
5	**A R^2**	.003			
6	**F Value**	1.034			
7	**Significant**	.393*			

Source: Estimatio n based on CGWB(2011).

In the above table 7 explained here in the regression analysis explained that Dependent variable for this analysis is population is 361079.92. change in total Net groundwater availability was 6.421 and groundwater availability for future irrigation was 7.828 and Projected demand for groundwater was 20.757. The Value of R^2 for selected variables was (.100) which implies that variation of total demand in India was explained by the selected independent variables. From the table 11 it can be inferred that net groundwater availability and future availability for irrigation and projected demand for groundwater is significant at 1 per cent level individually to determine the total irrigation in India. The F Value was 1.034 was significant at all the selected variables together were significant to affect the total demand in India.

Table 8 Ground Water Level in Selected Disricts of Tamilnadu

S. No.	District	Population as on (2011)	Semi-Critical [>70per cent]	Critical [70per cent-90per cent]	Over Exploited 90per cent-100per cent
1	Chennai	4681087	-	-	20
2	Coimbatore	3472578	9	1	21
3	Dindigul	2161367	12	2	21
4	Salem	1341250	6	-	29
5	Tirupur	3072880	5	1	23
6	Vellore	3928106	20	3	26
7	Villupuram	3463284	10	2	32
8	Thanjavur	735071	8	-	29

Source: CGWB (2011)

Demand - Supply Gap

The total water potential of the State including cross border contribution from Andhra Pradesh, Karnataka and Kerala was 1775.60 TMC (47,680 MCM). This also includes ground water potential of about 20,649 MCM. The sectoral demand for water in 2011 was 49,773 MCM,

which is about 2000 MCM more than the potential availability. The demand is projected to increase to 48,766 MCM and 55,919 MCM in 2020 and 2045 respectively. The gap between supply and demand by 2020 is expected to be 5,211 MCM (11 per cent) and it is likely to go up to 17 per cent by 2050, if there is no intervention. Therefore, all possible measures have to be taken to reduce the gap. The sectoral wise demand for water resources is shown in table 9 below

Table 9 Sector Wise Water Demand

S.No	Sector/ Year	2011	2020	2045
1	Domestic	2248	2608	3908
2	Irrigation	38032	38032	38302
3	Livestock	965	965	965
4	Industrial & Power	3884	5318	10774
5	Eco& Env Recreation & minimum Flow needs	519	1843	1970
	Sub Total	**45648**	**48766**	**55919**
6	Add for existing 45 per cent overall irrigation efficiency instead of 60 per cent adopted in calculating irrigation for Cauvery basin	4125	4125	-
	Grand Total	**49773**	**52891**	**55919**

Source: TamilNadu state action plan for climate change, (2011).

Conclusion

India occupies only 3.29 million km geographical area, which forms 2.4 per cent of the world's land area. It supports over 17.5 per cent of the world population. The population of India is 121 crores. Thus, India supports 1/6th of world's population.1/50th of worlds land and 1/25th of world's water resources. India is endowed with a rich and vast diversity of water resources. India has seasonal rainfall with high temporal and spatial variability. Ground Water About per cent of Tamil Nadu comprises of hard crystalline rocks and 27 per cent comprises of sedimentary formation representing various geological formations from the Precambrian to the recent formations. The total available ground water in Tamil Nadu as per the Ground water estimation Committee is 734 TMC. If water is not managed more prudently – from source, to tap, and back to source – the crises observed today will become the catastrophes of tomorrow. The State is constructing check dams to arrest runoff and attempt storage of water for beneficial use. State is entirely dependent on rains for recharging its water resources, monsoon failures lead to acute water scarcity and severe droughts. There is an imminent need to deepen our understanding of our water resources and usage and put in place interventions that make our water use efficient and sustainable.

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ACHIEVING WATER SECURITY THROUGH VIRTUAL WATER TRADE – OPPORTUNITIES AND CHALLENGES

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Abstract

Water resources in India have been subjected to tremendous pressures from increasing population, urbanization, industrialization, and modern agricultural methods. Water problem in India could be mitigated by increasing the productivity of limited water resources through rational water use allocation. Virtual water trade between nations and even continents could thus be used as an instrument to improve global water use efficiency and to achieve water security in water-poor regions of the world. This paper attempts to analyze virtual water trade as a solution for the existing water crisis in India. The pros and cons of virtual water trade and the conditions under which it could benefit the countries under water stress are discussed in this paper.

Keywords: *Water Scarcity, Water Security, Virtual Water, Water Management, Food Security*

Introduction

Water is one of the most basic human needs and is indispensable to almost all economic activities, including agriculture, energy production, industry, mining etc. Yet water is under unprecedented pressure as growing population and competing economic sectors demand more of it leaving insufficient water to meet human needs. Water scarcity affects more than 40 per cent of the global population. Groundwater reserves are depleted in many places, leaving current and future generations with close to no buffer against increased climate variability. Although, India is not a water poor country, due to growing human population, severe neglect and over-exploitation of this resource, water is becoming a scarce commodity. India has access to only four per cent of usable water sources and the annual per capita availability of water in the country has plummeted significantly and many Indians lack access to safe drinking water. Sustainable development cannot be achieved without a water secure world. A water secure world reduces poverty, advances education, and increases living standards. It is a world where there is an improved quality of life for all.

Water Scarcity in India

Despite water being an existential need for humans, it's also one of the most under-prioritized and over abused commodity. Water is central to our lives but has not been the central point of focus in our planning while we rapidly evolve into an urban society (Debu, 2014). In India, more than 330 million people, around a quarter of the population, are facing acute water shortage. Water scarcity in India is expected to worsen as the overall population is expected to increase. 75.8 million Indians, currently lack access to clean water, with children in 100 million homes lacking access to clean water. Climate change and water mismanagement has further exacerbated the crisis (Bilandani, 2017). Post-independence, due importance was given to harnessing water by storing it in dams. However, new cities and towns have subsequently grown without planning for water (Debu, 2014). According to the Ministry of Water Resources, the per capita water availability in the country as a whole is reducing progressively due to increase in population. The average annual per capita availability of water in the country, taking into consideration the population of the country as per the 2001 census, was 1816 cubic meters which decreased to1545 cubic meters as per the 2011 census. Water scarcity is mostly man made due to excess population growth and mismanagement of water resources. Some of the major reasons for water scarcity are:

a) Inefficient use of Water for Agriculture

India is among the top growers of agricultural produce in the world and therefore the consumption of water for irrigation is amongst the highest. Traditional techniques of irrigation cause maximum water loss due to evaporation, drainage, percolation, water conveyance, and excess use of groundwater. As more areas come under traditional irrigation techniques, the stress for water available for other purposes will continue. The solution lies in extensive

use of micro-irrigation techniques such as drip and sprinkler irrigation.

b) Reduction in Traditional Water Recharging Areas

Traditional water bodies are ignored that has acted as ground water recharging mechanism. So, it is the need of the hour to revive traditional aquifers while implementing new ones.

c) Sewage and Wastewater Drainage into Traditional Water Bodies

Release of chemicals and effluents into rivers, streams and ponds is the problem which has to be tackled by strict monitoring and implementation of laws by the government, NGOs and social activists.

d) Lack of on-time de-silting Operations

Without on-time de-silting operations in large water bodies, water storage cannot be enhanced during monsoons. The governments at state levels should take this up on priority as an annual practice to improve the water storage levels.

e) Lack of Efficient Water Management and Distribution

Proper water management and distribution of water between urban consumers, the agriculture sector and industry is needed. For this, the government needs to invest in technology and include all stakeholders at the planning level to ensure optimization of existing resources.

Need for Water Security

A country whose renewable fresh water availability on an annual per capita basis, exceeds about 1,700 cubic meters will suffer only occasional or local water problems. Below this threshold countries begin to experience periodic or regular water stress. When fresh water availability falls below 1,000 cubic meters per person per year, countries experience chronic water scarcity, in which the lack of water begins to hamper economic development and human health and well-being. When renewable fresh water supplies fall below 500 cubic meters per person, countries experience absolute scarcity. In India, continued population growth and the impact of global warming along with inadequate conservation and huge wastage are putting enormous pressure on water resources. With no proportional increase in water availability and an ever increasing demand, a water crisis seems imminent (IDSA Task Force Report, 2010). Experts warn that the country could be hit hard by water scarcity by 2050. The issue of water security is double-sided. Firstly, India suffers from an absolute water shortage; there is simply not enough safe water to satisfy the rapidly increasing population and the rapidly increasing demand as a result of an expanding middle class. Secondly, India is mismanaging the way water is produced, consumed and distributed. As water is the most essential resource for attaining India's commitments to achieving the Sustainable Development Goals of zero hunger and zero poverty, it is mission critical to address this concern. Water conservation driven by enhanced storage, delivery and conservation feature high on the country's water security agenda (Kapoor, 2016). Water security can be defined as access at all times to sufficient good quality water to satisfy varied needs (Singh, 2017). Water security means the sustainable availability of water quantity and quality acceptable for production, livelihoods and health, coupled with an acceptable level of risk to society related to unpredictable water-related impacts (Frone and Frone, 2015).

Water Security and Virtual Water

Water security remains an elusive goal for many countries, in spite of the clear benefits of investing in water, sanitation and hygiene. The World Economic Forum's 10th Global Risk Report ranked water crises as the top global risk in terms of impact, more than the spread of infectious diseases, weapons of mass destruction or interstate conflict.

One increasingly pressing issue is the widening gap between the supply of water resources and the demand for water services in rapidly growing urban areas. This is exacerbated by dwindling resources in the face of climate vulnerability, and a legacy of poor governance and wasteful uses. Water security can be attained by virtual water trade.

Virtual water is the water used in the production process of goods and services, and virtual water strategy means countries or regions whose water is scarce achieve their water security and food security by importing water-intensive products from those whose water is abundant. As an attractive instrument to water scarce countries, virtual water has received more and more attention and been applied to relieve the pressure on the nation's own water resource and solve food scarcity (Guodong, 2003-04). Uneven geographical distribution of natural resources, the demand for water and crude oil cannot always be met by the local supply. While crude oil is often directly transported to fill the gap, using barges, tankers, pipelines, trucks, and trains, water is not usually transported directly over long distances. Although there are some cases of direct water exports, neither a global market nor a

standard global price exists for water. Instead, the international trade in water-intensive commodities between water-abundant and water-poor countries can help water-poor countries save resources; this process is known as the 'virtual water trade' (Oki et.al., 2017). For the water scarce countries it is attractive to achieve water security by importing water-intensive products. At the same time water rich countries can profit from their abundance of water resources by producing water-intensive products for export. The national economy can balance its water needs by accessing invisible water outside its national boundaries (Nassar, 2007).

Virtual water is crucial politically, because it enables the political leaderships to avoid confronting the water deficit. Water deficient economies receive a double benefit through accessing embedded virtual water at an incalculably advantageous price. Virtual water prevents water crisis from becoming water wars (Allan, 1998). Trade in virtual water is much more feasible and affordable than transferring real water resources, and makes it possible for water-scarce countries to effectively cope with poor resource endowments. Although the concept of virtual water has received some critiques from economists questioning its validity as a policy prescription, the role of virtual water trade and virtual water import dependency should be recognised at the policy level (Antonelli and Tamea, 2015). The economic argument behind virtual water trade is that, according to international trade theory, nations should export products in which they possess a relative or comparative advantage in production, while they should import products in which they possess a comparative disadvantage (Wichelns, 2001).

Virtual water and water footprints have been important in highlighting the role of water resources in international trade. However, some caution should be used when the concepts are applied to important policy questions. International trade is complex and involves many issues that are not captured in the notion of virtual water. For instance, water foot printing analysis has been used to suggest that water-short countries should not produce and export water-intensive crops. This could encourage policymakers to promote production and trade strategies that reduce social net benefits. Several water-short countries, such as Israel, Jordan, and Australia, produce and trade water-intensive products. Those activities generate substantial revenue for the producers, while enhancing the portfolio of goods and services available in both the exporting and importing countries. The virtual water perspective also neglects consideration of the impacts of production and trade on the livelihoods of individuals and the vibrancy of communities engaged in agriculture. Proposals to re-arrange international trading patterns based only on consideration of water endowments could impose substantial harm on individuals who earn their living in agriculture, particularly in poor countries. The suggestion that a water-short nation should import a water-intensive crop from a water-abundant nation will not be correct if the water-short nation has a comparative advantage in producing the water-intensive crop. There also may be situations in which a water-short nation cannot gain from trade with a water-abundant nation. Policy discussions and recommendations can be enhanced by examining resource endowments and production technologies, and evaluating opportunity costs when using the virtual water. Estimating opportunity costs and evaluating comparative advantages requires more effort than examining resource endowments. However, the potential gains from identifying optimal strategies and implementing appropriate policies can be substantial (Wichelns, 2004).

When a country opts consciously for virtual water imports to alleviate its water problem, it is also making a choice of altering its cropping patterns in a significant way. This could deprive farmers and their families of their livelihoods unless alternatives are developed in terms of other crops or alternative employment. In their absence, this choice could have serious fallout, as unemployment is a problem most of the virtual water importing countries already faces.

Conclusion

Increasing water scarcity worldwide calls for sustainable, efficient and equitable management of scarce water resources, at international, regional, and local levels. With rapid economic growth, population growth and urbanization, India features among the highest water users. According to a report released by NITI Aayog, India is facing its worst water crisis in history and if no action is taken to address this, the demand for water would far outstrip its supply by 2030. In fact, even by 2020, it is expected that 21 Indian cities will run out of groundwater. Water problem in India could be mitigated by increasing the productivity of limited water resources through rational water use allocation.

Virtual water trade between nations and even continents could thus be used as an instrument to improve global water use efficiency and to achieve water security in water-poor regions of the world. However, water savings from the projected large increases of water-intensive food imports by the developing countries are particularly

beneficial if they are the result of strong economic growth that generates the necessary foreign exchange to pay for the food imports. More serious food security problems arise when high food imports are the result of slow agricultural and economic development that fails to keep pace with basic food demand driven by population and income growth. Under these conditions, countries may find it impossible to finance the required imports on a continuing basis. Hence, virtual water trade as a policy recommendation for solving the water crisis must be made after carefully examining the opportunity costs and evaluating the comparative advantage of the country in question. In spite of all its shortcomings, the concept of virtual water has certainly lent a new perspective to discussions on water management and the inter-linkage between water, food and trade.

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AN OVERVIEW ON CAUSES AND CONSEQUENCES OF WATER POLLUTION IN INDIA

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Abstract

Water is a key resource for our quality of life, the things we grow and produce. Access to clean water for drinking and sanitary purposes is a precondition for human health and well-being. In some parts the quality still frequently does not meet basic biological and chemical standards. Clean unpolluted water is also essential for our ecosystems. Plants and animals in lakes, rivers and seas react to changes in their environment caused by changes in chemical water quality and physical disturbance of their habitat. Almost all human activities can and do impact adversely upon the water. Water quality is influenced by both direct point source and diffuse pollution which come from urban and rural populations, industrial emissions and farming. With this background the study aims to review about the various reasons for water pollution and its problem in India.

Keywords: *Water, Quality, Pollution, Human Health*

Introduction

Water is the basis of all life. It is fundamental for human existence, ecological balance and for the very future of our planet. Safe drinking water is a basic need and a right for every human being. Clean, safe and adequate fresh water is vital to the survival of all organisms and the smooth functioning of key systems, entities and economies. Water based eco-systems provide a diversity of services vital for human well-being and poverty alleviation and the delivery of fresh water is a particularly important service both directly and indirectly (PAC,2015). With growing urbanization and industrialization India faces the challenge of providing clean and safe drinking water to all citizens. Water pollution is a serious problem in India as almost 70 per cent of its surface water resources and a growing percentage of its groundwater reserves are contaminated by biological, toxic, organic, and inorganic pollutants. In many cases, these sources have been rendered unsafe for human consumption as well as for other activities, such as irrigation and industrial needs. When toxic substances enter lakes, streams, rivers, oceans, and other water bodies, they get dissolved or lie suspended in water or get deposited on the bed. This results in the pollution of water whereby the quality of the water deteriorates, affecting aquatic ecosystems. Pollutants can also seep down and affect the groundwater deposits.

Olaniran (1995) defined water pollution to be presence of excessive amounts of a hazard (pollutants) in water in such a way that it is no long suitable for drinking, bathing, cooking and other uses. Water pollution is now a day's considered not only in terms of public health but also in term of conservation, aesthetics and preservation of natural beauty and resources. Water is a major environmental issue in India. The largest source of water pollution in India is untreated sewage. Other sources of pollution include agricultural runoff and unregulated small scale industry. Most rivers, lakes and surface water in India are polluted. Lack of water, sanitation, and hygiene results in the loss of 0.4 million lives while air pollution contributes to the death of 0.52 million people annually in India (WHO 2007). Environmental factors contribute to 60 years of ill-health per 1,000 population in India compared to 54 in Russia, 37 in Brazil, and 34 in China. The socio-economic costs of water pollution are extremely high.

In India, every year, approximately 50,000 million liters of wastewater, both industrial and domestic, is generated in urban areas. If the data of rural areas is also taken into account, the overall figure will be much higher. According to a United Nations report released on March 22, 2010 on World Water Day, 80 percent of urban waste in India ends up in the country's rivers, and unchecked urban growth across the country combined with poor government oversight means the problem is only getting worse (Subodhet.al.2017).Pollutants in water include a wide spectrum of chemicals, pathogens and physical chemistry or sensory changes. Many of the chemical substances are toxic. Pathogens can produce waterborne diseases. Alteration of water's physical chemistry includes acidity, electrical conductivity, temperature and eutrophication. Human infectious diseases are among the most serious effects of water pollution. McKenzie and Ray (2004) also

observe similar effects of water pollution; however, the magnitude of the effect was modest. The study shows that India loses 90 million days a year due to water borne diseases with production losses and treatment costs worth Rs 6 billion. Poor water quality, sanitation, and hygiene result in the loss of 30.5 million disabilities adjusted life years (DALY) in India.

In India main causes of water pollution, including sewage, manure, and chemical fertilizers, contain "nutrients" such as nitrates and phosphates. Deposition of atmospheric nitrogen (from nitrogen oxides) also causes nutrient-type water pollution. In excess levels, nutrients over-stimulate the growth of aquatic plants and algae. Excessive growth of these types of organisms clogs our waterways and blocks light to deeper waters while the organisms are alive, when the organisms die, they use up dissolved oxygen as they decompose, causing oxygen-poor waters that support only diminished amounts of marine life. Such areas are commonly called dead zones. Nutrient pollution is a particular problem in estuaries and deltas, where the runoff that was aggregated by watersheds is finally dumped at the mouths of major rivers (Rajshree, 2011). Basic Facts of Water pollution when toxic substances enter lakes, streams, rivers, oceans, and other water bodies, they get dissolved or lie suspended in water or get deposited on the bed. This results in the pollution of water whereby the quality of the water deteriorates, affecting aquatic ecosystems.

Causes of Water Pollution In India

Water pollution has been another major environmental concern in India. The pollution-levels have been increasing over the decades. This has lead to the death of many both man and animals. In 2012, the Ministry of Drinking Water and Sanitation estimated about 600 increased cases of death due to water-borne diseases like typhoid, chronic gastritis and diarrhea, led by drinking contaminated water, as compared to that in 2011. There are several causes to this deadly problem like untreated sewage, wastes from factories and small scale industries, domestic wastes and a number of religious malpractices. Some of the major factors which are responsible for causing water pollution or degradation can be enumerated as growing population, rapid industrialization, and urbanization, use of science and technology and modern agriculture practices.

- Growing Population Every year we add millions of people to the world population and our country is no exception. The growth of population gave rise to increase in wants and demands of mankind and has succeeded in creating acute problem of water pollution.
- Industrialization Rapid industrialization is another cause of worry as far as water pollution is concerned. But to our utter surprise industrialization along with development brought with it a danger to the human civilization- the problem of environmental pollution.
- Urbanization is also another major factor which contributes significantly towards environmental pollution.
- The nature of productive technology in recent years is closely related to the environmental crises. This factor has been largely responsible for the generation of synthetic and non biodegradable substances such as plastics, chemical nitrogen fertilizers, synthetic detergents, synthetic fibres, big cares petrochemical and other environmentally injurious industries and disposable culture.
- The tremendous sewage problem at a massive level which is left untreated. Due to insufficient sewage treatment plants in the cities, and a majority of sewage treatment plants established by the government staying closed most of the time due to maintenance issues; the domestic wastes stay untreated and are expelled to the water bodies. This pollutes them badly.
- Another serious fact about this problem is the lifestyle of people that comprises of several malpractices involving dirtying the water, giving it the name of religion or rituals. The rituals associated with right from the birth of a child to the death, involve water pollution in some or the other way. Even the shaved hairs of a child after the mundan ceremony are immersed in the river. In the holy cities like Haridwar, Rishikesh and Varanasi, to wash away their sins, people take 'holy dips' in these rivers in very large numbers every day. The devotees immerse thousands of idols of deities into the water. The chemicals used in their making, pollute the rivers badly.
- The untreated factory wastes have been adding up to the seriousness of this issue since

decades. The advent of small scale industries in India led to the huge growth of the rural and economically poorer sections but at the same time increased the problem of water pollution.

- The massive pollution has been caused by time to time oil spills from the ships on the oceanic waters.
- Modern agricultural practices and application of new technological processes in the field of agriculture severely affect the environment. Inorganic fertilizers are being widely used now-a-days. Fertilizers like phosphates and nitrates cause wide spread damage when applied carelessly to crops.
- Domestic sewage Refers to waste water that is discarded from households. Also referred to as sanitary sewage, such water contains a wide variety of dissolved and suspended impurities.
- Shipping is one of these non-spill sources of oil pollution in water: Discharge of oily wastes and oil-contaminated ballast water and wash water are all significant sources of marine pollution, and drips from ship and boat motors add their share.
- Plastic that has broken down into micro-particles is now being ingested by tiny marine organisms and is moving up the marine food chain. Sea creatures that are killed by plastic readily decompose.

Major Effects of Water Pollution

Water pollution can have some tremendously-adverse effect on the health of any and every life form living in the vicinity of the polluted water body or using water that has been polluted to some extent. At a certain level polluted water can be detrimental to crops and reduce the fertility of soil thus harming the overall agricultural sector and the country as well. When sea water is polluted it can also impact oceanic life in a bad way. The most fundamental effect of water pollution is however on the quality of the water, consuming which can lead to several ailments. In fact as far as India is concerned polluted water is one of the major factors behind the general low levels of health in India, especially in the rural areas. Polluted water can lead to diseases such as cholera, tuberculosis, dysentery, jaundice, diarrhoea, etc. In fact, around 80% stomach ailments in India happen because of consuming polluted water. The effects of water pollution are numerous. Some water pollution effects are recognized immediately, whereas others affect will donot show up for months or years.

- The food chain is damaged. When toxins are in the water, the toxins travel from the water the animals drink to humans when the animals' meat is eaten.
- Diseases can spread via polluted water. Infectious diseases such as typhoid and cholera can be contracted from drinking contaminated water. This is called microbial water pollution.
- The human heart and kidneys can be adversely affected if polluted water is consumed regularly. Other health problems associated with polluted water are poor blood circulation, skin lesions, vomiting, and damage to the nervous system. In fact, the effects of water pollution are said to be the leading cause of death for humans across the globe.
- Acid rain contains sulfate particles, which can harm fish or plant life in lakes and rivers.
- Pollutants in the water will alter the overall chemistry of the water, causing changes in acidity, temperature and conductivity. These factors all have an effect on the marine life.
- Marine food sources are contaminated or eliminated by water pollution. Altered water temperatures (due to human actions) can kill the marine life and affect the delicate ecological balance in bodies of water, especially lakes and rivers.
- Water pollution effects have a huge impact on our environment and health. The delicate
- balance between nature and humans can be protected, but it will take efforts on all fronts to prevent and eliminate water pollution locally and globally

Steps To Prevent Water Pollution

Water pollution has a huge impact in our lives. These are the various steps we can follow to prevent water pollution.

- Use fewer chemicals to clean your home
- Dispose of waste properly
- Don`t flush medication and trash
- Conserve as much water as possible
- Avoid using plastic
- Recycling and Reuse of water

- Don`t use pesticides and herbicides
- Removed concrete surfaces and replace them with ground cover
- Prevent soil erosion from occurring
- Inspects your septic system every 3-5 years
- Help clean up litter in water filled areas
- Speak up about water issues that affect your community
- Finally Enforcing Laws to prevent water pollution

Conclusion

Clean, safe and adequate fresh water is vital to the survival of all organisms and the smooth functioning of key systems, entities and economies. The effects of water pollution are not only devastating to people but also to animals, fish, and birds. Polluted water is unsuitable for drinking, recreation, agriculture, and industry. It diminishes the aesthetic quality of lakes and rivers. More seriously, contaminated water destroys aquatic life and reduces its reproductive ability. Eventually, it is a hazard to human health. Nobody can escape the effects of water pollution. Water quality is influenced by both direct point source and diffuse pollution which come from urban and rural populations, industrial emissions and farming. Thus, an environmental crisis is the inevitable result of a counter ecological pattern of productive growth

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WATER AS AN ECONOMIC GOOD

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Abstract

Water plays an important role in the world economy. Approximately 70% of the freshwater used by humans goes to agriculture. Water is very much Important role play in all biotic organism. From a biological standpoint, water has many distinct properties that are critical for the proliferation of life. It carries out this role by allowing organic compounds to react in ways that ultimately allow replication. All known forms of life depend on water. Water is vital both as a solvent in which many of the body's solutes dissolve and as an essential part of many metabolic processes within the body.

Introduction

Natural resources carrying zero price. Such as air, water and sun light. Now a day, water is one of the commercial products everywhere because of scarcity. Water fit for human consumption is called drinking water or potable water. Water that is not potable may be made potable by filtration or distillation, or by a range of other methods. Water is an excellent solvent for a wide variety of chemical substances; as such it is widely used in industrial processes, and in cooking and washing. Water is also central to many sports and other forms of entertainment, such as swimming, pleasure boating, boat racing, surfing, sport fishing, and diving.

Principle of Water usage

Agriculture

The most important use of water in agriculture is for irrigation, which is a key component to produce enough food. Irrigation takes up to 90% of water withdrawn in some developing countries and significant proportions in more economically developed countries. This is because there are now nearly seven billion people on the planet, their consumption of water-thirsty meat and vegetables is rising, and there is increasing competition for water from industry, urbanisation and biofuel crops. In future, even more water will be needed to produce food because the Earth's population is forecast to rise to 9 billion by 2050.

Drinking

The human body contains from 55% to 78% water, depending on body size. To function properly, the body requires between one and seven liters of water per day to avoid dehydration the precise amount depends on the level of activity, temperature, humidity, and other factors. Most of this is ingested through foods or beverages other than drinking straight water. It is not clear how much water intake is needed by healthy people, though most specialists agree that approximately 2 liters (6 to 7 glasses) of water daily is the minimum to maintain proper hydration. Medical literature favors a lower consumption, typically 1 liter of water for an average male, excluding extra requirements due to fluid loss from exercise or warm weather.

Washing

The propensity of water to form solutions and emulsions is useful in various washing processes. Washing is also an important component of several aspects of personal body hygiene. Most of personal water use is due to showering, doing the laundry and dishwashing, reaching hundreds of liters per day in developed countries.

Sanitation, Health and Hygiene practice:

There are clear benefits to be gained from improved access to water and sanitation including reductions in water related mortality and morbidity and positive impacts on productivity, child development and quality of life. Women's care responsibilities are often increased by water-related diseases, thus intensifying their labour, reducing the amount of water they can collect, and limiting the time they can spend working or engaging in community action.

Gender and sanitation Improved sanitation is critically linked to achieving the health benefits of clean water supplies, as it helps to reduce the risk of faeco-oral transmission of disease. Well-used sanitation facilities, along with health education and greater water use, are thought to reduce the mortality caused by diarrhoeal disease by about 65 per cent and morbidity by 26 per cent. At the 2002 World Summit on Sustainable Development held in Johannesburg, South Africa, a target was set to reduce by half the proportion of the 40 per cent of the global population lacking satisfactory sanitation by 2015. This target was later reinforced as one of the targets of the Millennium Development Goals. A number of social and gender issues relate to the achievement.

Water required for different activities

Water Required for Different Activities A number of factors like climate, culture, food habits, work and working conditions, level and type of development, and physiology determine the requirement of water. As per the Bureau of Indian Standards, IS:1172-1993, a minimum water supply of 200 litres per capita per day (lpcd) should be provided for domestic consumption in cities with full flushing systems. IS:1172-1993 also mentions that the amount of water supply may be reduced to 135 lpcd for the LIG and the economically weaker sections (EWS) of the society and in small towns [Modi 1998]. Besides domestic requirement, water is also demanded for commercial, industrial, and civic or public use. The IS:1172-1993 gives the total requirement of water in industrial and commercial towns with full-flushing system as 280 lpcd. The Ninth Plan (1997-2002) had advocated the requirement of water in urban areas as 125 lpcd in cities with planned sewerage systems; 70 lpcd in cities without planned sewerage systems; and 40 lpcd for those collecting water from public stand-posts. However, in the Tenth Plan (2002-07), the cities with planned sewerage systems are classified into two groups based on population **(Abdul Shaban, R N Sharma).**

Conclusion

Water is scarce resources; more water consuming economic lead economic activities and population growth are responsible for decline percapita water availability. As per the Bureau of Indian Standards, IS:1172-1993, a minimum water supply of 200 litres per capita per day (lpcd) should be provided for domestic consumption in cities with full flushing systems. It is very crucial problem for the world. The urban population is quite large in sheer numbers, viz, around 290 millions. This would need a systematic augmentation of water supply to urban areas, without threatening the available water resources for rural areas.

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THE ROLE OF RURAL WOMEN IN WATERSHED DEVELOPMENT PROJECT

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Abstract

Women especially from the small and marginal farming families perform over 60% of on-farm activities and almost all off-farm activities. Village women play an important and significant role in watershed development activities. The present study was carried out in Soorapattu Village of Kanai block of Villupuram District in Tamilnadu to know the level of participation of village women in watershed development practices. Today the women's role is more and more seen as the key for managing social interaction with nature. Such role could be instrumental in dealing with the current crisis in the Soorapattu watershed. This study investigated women's participation in watershed management at the household level using a theoretical model based on elements from the gender socialization theory and empowerment theory to find out what women know, how they manage, and what factors are related to their empowerment. Data from questionnaires from 50 women in Soorapattu village was analyzed. The study revealed that village women had medium/average participation in watershed practices and also important significant role in the watershed. The income level benefit increased after implement the watershed project.

Keywords: *Rural women; Participation; Watershed development; Experiences.*

Introduction

The total population of India is about 1.21 billions, out of which the rural populations of India is about 69.9 per cent. In rural population 48.37 per cent are females. A characteristic feature in the present day rural area is remoteness, absence of good communication facilities and poor utilization of natural resources. The State of Tamil Nadu is among the few States of India, which has lower infrastructural development than the national standards, in rural areas. Rain fed agriculture in India is characterized by low productivity, degraded natural resources and widespread poverty. This issue made the development planners to implement productive, environmentally sustainable, socially equitable, land and water management. It is in this context, the concept of watershed development has been introduced in our country. A watershed is a geographical area that drains to a common point, which makes it an attractive unit for technical efforts to conserve soil and maximize the utilization of surface and sub-surface water for crop production (Kerr, et al, 2000).

Watershed development has been conceived basically as a strategy for protecting the livelihoods of the people inhabiting the fragile ecosystems experiencing soil and moisture stress. The aim has been to ensure the availability of drinking water, fuel wood and fodder and raise income and employment for farmers and landless laborers through improvement in agricultural production and productivity (Rao, 2000).Watershed development has been conceived as one of the important rural development programmes in India where the rain fed agriculture is characterized by low productivity, degraded natural resources and widespread poverty. The Self-Help Groups (SHGs) in micro watersheds have received much attention from the policy makers and others for their perceived ability to contribute significantly to the economic growth and poverty alleviation. The formation of SHGs has been made mandatory in all watershed development programmes in the country. The Project Implementing Agency (PIA) has been empowered to constitute SHGs in the watershed areas. These groups are homogenous groups having common interest who are dependent on the watershed area such as: landless laborers, agricultural laborers, rural women, shepherds, scheduled castes/tribes etc. Around 50 per cent of villagers who are directly or indirectly dependent on watersheds should generally be enrolled as members in the SHGs. Evidences show that the SHGs are formed mostly for Women-oriented activities. Separate SHGs should be formulated for Women, Scheduled Caste (SC) and Scheduled Tribes (ST). SHGs function mostly as thrift, savings and lending groups and experiences show that there are vast differences in functioning. In addition, the SHGs are also formed for activities such as: coconut palm thatches knitting, running canteen, sweet stalls, grocery shop, petty shop, rice mundy, textile shops etc (Palanisami

et al, 2002). Women spend 2.2 hours/day/household in animal care activities. Men contribute about 50% of the labour involved in grazing activity only. All other activities such as shed -cleaning, milking, harvest and transport of grass for livestock are performed exclusively by women. Women spend about 31% of their labour in animal care activities. Women and children together put in about 60% of the labour in various livestock maintenance activities. In a Himalayan village in Uttar Pradesh women spend about 547.5 hours/person/year in animal care activities and 1621 hours/person/year in fodder collection activities along with children, mainly girls. Studies in Pakistan, Egypt and Chile have shown that rural women do about 80-100% of the work of maintaining and managing poultry. Women are responsible for over half the food production in developing countries. The major component of women's labour in crop production is utilized in transplanting, weeding and harvesting activities. These activities are arduous, time-specific and critical operations, and determine the productivity of crops. According to one study, of every 100 „man-hours"" in various agricultural operations, 74 are woman-hours. Women generally are not involved in activities where bullocks are used such as ploughing and transport. Studies on agricultural operations show an increasing involvement of women in crop production. However, the role of women in the planning of agricultural development is marginal. The rural population of Tamilnadu constitutes around 55.59 per cent of the total population of the State (2011 Census). Such rural people have a definite way of life and particular socio-cultural and religious characteristics. The government efforts have been directed to bring about social, economical, educational and cultural development of the people by implementing various programme like watershed management programme. People's willingness and cooperation are the important factors, which determine the success of watershed development programme. Watershed development is essentially a group and community oriented programme. Rural women actively participate in different activities i.e. soil-water conservation, crop production practices, practices for fodder, fuel and vegetable production and other practices like poultry, goat rearing, small scale industry etc. But rural women's contribution in sustainable agriculture system and watershed practices has been inadequately understood or largely ignored. Hence, an investigation was conducted with the following specific objectives:

1. To determine the extent of participation and role played by rural women in watershed development programme.
2. To know the association of socio-personal with extent of participation.

Study Area

Soorapattu watershed is situated in Kanai block of Villupuram District, Tamil Nadu. Soorapattu watershed covers an area of about 1218.50 ha. The nearest river is south pennayaru.

Methodology

The study was conducted during 2017 in Soorapattu village of Kanai block of Villupuram district. The methodology adopted for the present area includes collection of following data:

- Personal interview and discussion from local rural women
- Observations of the SHGs in the watershed
- Analysis of the income level benefits from the watershed
- Focus group discussions with SHG group member.

Results and Discussion

In general, watershed programmes had been purely land based development programmes and there had been only a marginal scope for involving women and landless poor. In fact, it is women who attend to collection of fuel wood, fodder, non wood forest produce etc., in rural areas, but their choices or opinions have been often ignored. Though women are being involved in watershed programmes, their involvement in watershed management had been limited mainly due to limitations such as lack of land ownership (entitlements), credit and capabilities, low literacy, lack of productive skills and suitable technologies etc. In general following were observed.

- Women get Opportunity to earn wages through earth treatment in the watershed.
- Increase availability of drinking water in the watershed area.
- Foods through increase in cropping intensity in the watershed.
- Increase in fuel wood availability on common land.
- Provision of water for women in productive use.

A. Women Promotion/ Gender Integration

For gender mainstreaming and empowerment of women, women are involved at every stage of the project. The VWC (Village Watershed Committee) has at least 30% representation by women. Further, there is a special provision of Women's Development Fund under the programme by earmarking 5% of project funds for forming SHGs and promoting savings and lending activities, and for taking up 'Social Development' and 'Income generating activities'. A trained Lady Social Worker is employed to address women related issues. The activities which have been taken up by women out of this fund so far include:

- drinking water schemes,
- drainage repair,
- soak pits,
- kitchen gardens,
- community halls,
- flour mill on group basis,
- dairy, poultry, stall fed goat rearing,

B. Women Involvement

The natural resources which are directly concerned with rural poor women are drinking water, fuel wood and fodder. The needs of these women with specific reference to available natural resources have to be identified. The objectives of the watershed project should be framed based on the needs of women. Based on the requirement, exclusively women user groups can be formed or proper representation should be there in the user groups and watershed committees. Women should be involved in planning and implementation of watershed activities at all stages.

- Formation of women SHGs and networking them into user groups or watershed committees.
- Increasing access to resources, ownership of assets created.
- Imparting leadership skills to resourceful women and new skill development.
- Equal wages and opportunities.
- Sensitizing the women with respect to health education, nutrition, literacy, girl child education and social evils like dowry, child marriages, violence etc. Livelihoods, employment and linkages with banks.
- Participation in community development programmes.

Activities

- Drinking water can be taken up as entry point activity. It can be augmenting the existing source or creating a new source or attending to fluoride problem etc.
- Soil moisture conservation measures like soil bunding, field bunding, raising agro forestry species on the bunds, rock fill dams; check dams can be taken up by women user groups.
- Raising plantations in the common lands and avenue plantation can be taken up.
- Horticulture, Vermiculture, green manuring.
- On-farm crop demonstrations of improved agronomic practices involving women farmers.
- Raising green fodder for cattle and teaching scientific feeding practices.
- Adopting smokeless Stove.
- Taking up various livelihood activities like tailoring, basket making, mat weaving, dairy, poultry etc.

Other Issues

- Literacy: Enrolling the women in adult literacy programmes and encouraging them to send their children to schools and seeing that drops-out are made to rejoin in the school.
- Health and Sanitation: Utilizing the services of a health organizer in bringing awareness among women regarding nutrition/malnutrition, communicable diseases, family planning and personal hygiene. The women have to be encouraged to go for individual sanitary latrines.
- Women SHGs can play a vital role in attending to the above issues.

Communication of Information

- Information regarding the latest technologies in Agriculture, Agro Horticulture, Animal Husbandry etc., should be communicated to the women SHGs.
- *Training Programmes:* Skill enhancement programmes and other training programmes on natural resources management, livelihood aspects and leadership aspects should be imparted to women.
- Encouraging women with entrepreneurial capabilities and bringing out collective strength of women.

- Government and interested NGOs have to play a vital role in the form of financial assistance, facilitating bank linkages, imparting training programmes, inducing transparency and accountability etc.

Expected Outcome

Women have to play a vital role in identification, prioritization and execution of all works through participatory approach involving all sections of people like women, men, farmers, landless and wage labour in the village. The collective social action will definitely result in empowering the women, improved wage employment, improved agricultural productivity, enhancement of sustainable livelihoods, improved education, health and family planning, adoption of non-conventional energy resources to reduce drudgery etc. If the watershed programmes are implemented with concern and sincerity, the women can be involved at all stages of implementation and the monetary and non-monetary returns will be significant.

Income-Level Benefits for Self Help Groups

One of the major components of various watershed guidelines is poverty alleviation. Increase in agriculture production, livestock, and labour work are the major sources of increase in the income levels of watershed beneficiaries. Also the whole gamut of Watershed-Plus activities, which focused extensively on livelihood enhancement of resource poor people (especially the landless) by facilitating them through SHGs and credit supply, is expected to increase their income level. Along with poverty alleviation, many watershed project guidelines and various committee reports also mention the equity concerns in the watersheds, indicating the need to improve the economic and social conditions of the resource-poor and disadvantaged sections in the watershed community. However, while analyzing the equitable nature of the outcome of the watershed projects, the limitations of the watershed approach must be recognized With this background, the next section analyzes the change in income of the people in the pre- and post project scenario and also explains this change in the background of equity across landholding status, which is also deeply rooted in the caste system. In the watershed area seven SHG benefited from NABARD loan (Table 1).

Table 1 Income level benefits for Self – Help Groups

Sl. No.	Name of the SHG	No of Members	Loan from NABARD (Rs)
1	Nelli SHG	12	360000
2	Mullai SHG	12	360000
3	Eyarkai SHG	12	360000
4	Muthalamman SHG	12	360000
5	Rajakaliamman SHG	12	360000
6	Kaliamman SHG	12	360000
7	Mariyamman SHG	12	360000

Training and Demonstration to the Women

Training and demonstration is conducted in the Soorapattu area. Two training programs namely: vermicompost preparation and animal feed preparation, which were organized is found to be really helpful to the local Women. The impact of the training programs has resulted in implementing the above activities in their own lands (Table 2).

Table 2 Training and Demonstration

Sl. No.	Name of Training	No of Beneficiaries
1	Vermicompost Preparation	24
2	Animal feed Preparation	60

Conclusion

Soorapattu village women play an important and significant role in watershed development activities. The role of Women in watershed projects is mainly to increase wages through the watershed earth works. The income generation activities were implemented through the watershed credit system. Village Women get livelihood assurance from watershed activities. Training and demonstration programs implemented have instilled confidence in them, resulting in implementation of vermicompost and animal feed preparation in their own lands. Another important role for women is their active participation in the watershed areas, through SHGs. Thus there is significant role and responsibility of women in watershed development activities of the project in the above region. This has resulted in better performance of the project and has also empowered the women especially their „economic status‟.

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DOMESTIC CONSUMPTION PATTERN OF WATER AMONG HOUSEHOLDS IN COIMBATORE CITY

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Abstract

Global consumption of water is doubling every 20 years, more than twice the rate of human population growth. The emerging scarcity of water has also raised a host of issues related to sustainability of the present form of economic development, sustained water supply, equity and social justice, water financing, pricing, governance and management. Changes in lifestyle and changes in consumption rate of water are also leading to pressure on fresh water resources. Patterns of water consumption vary with nation and communities depending on a multitude of factors like economic, cultural, climatic, water availability and accessibility as well. In this background an attempt is made to analyze the domestic consumption pattern of water among households in Coimbatore city.

Introduction

Water is essential to life and it works as a foundation stone for social and economic development of any country in the world. Global consumption of water is doubling every 20 years, more than twice the rate of human population growth. At present more than one billion people on earth already lack access to fresh drinking water. By the year 2025 the demand for freshwater is expected to rise to 56 percent above what currently available water can deliver, if current trends persist (Barlow 2003). The emerging scarcity of water has also raised a host of issues related to sustainability of the present form of economic development, sustained water supply, equity and social justice, water financing, pricing, governance and management. Changes in lifestyle and changes in consumption rate of water are also leading to pressure on fresh water resources. Patterns of water consumption vary with nation and communities depending on a multitude of factors like economic, cultural, climatic, water availability and accessibility as well.

Shaban and Sharma (2009) in their article on water consumption patterns in Domestic households in major cities" founded on the domestic use of water in major cities of India. They also dealt with the source of water supply, duration of municipal water supply and awareness about water conservation .They founded that a majority of 92 percentage of the respondents depend on municipal water supply for consumption purpose, and 18 percent of the respondents stated that they had 24 hours water supply in their areas. They further added that many were not aware of the rain water harvesting methods, which has a potensial to solve the emerging water crisis.

Singh (2003) explored the pattern of domestic water consumption in semi-arid Dhani Monabbatpur village of Hisar District in Haryana State of India. He founded that the respondents used highest amount of water for washing clothes and they depend government water supply for soft drinking water. Rainwater harvesting methods were not known to the respondents. He suggested that public awareness program through media could change the attitude of the respondents and as well as general public In this background an attempt is made to analyse the domestic consumption pattern of water among households in Coimbatore city is undertaken with the following

Objectives

1. To study the social status of the sample households and
2. To understand the domestic consumption pattern of the water among the selected households.

Methodology

The study adopted a simple random convenient sampling to collect the data from 100 respondents in and around Coimbatore city. Information required for the current study was obtained through a structured interview schedule. The study used simple percentage for analysis.

Findings

- 67 percentage of the respondents belonged to the age category of 20-40 years. Two percent of the respondents were in the age category of above 60 years.

- 75 percent of the respondents were female and 25 percent was male.
- 45 percent of the respondents of the respondents stated that they have completed their higher education and cent percent of the respondents were identified as literates.
- 61 percentage respondents are unemployed, 39 percentage of the respondents are employed
- 93 percentage of respondents are from nuclear family and 7 percentage of the respondents are from joint family
- 65 percentage of the respondents clean their vehicle weekly once.
- 75 percentage of the respondents use bucket as mode of cleaning.
- 73 percentage of the respondents has no pet animals and one percentage of the respondents
- 49 percentage of the respondents use municipal corporation water, whereas 3 percentage of the respondent use other mode
- 27 percentage of the respondents reported that they get water supply every 2 days.
- 41 percentage of the respondents are not using syntax tank, whereas 2 percentage of the respondents are using syntax tank
- 75 percentage of the respondents stated that they use Indian toilet, whereas 5 percentage of the respondents use both Indian and Western type of toilet.
- 58 percentage of the respondents use bucket water to take bath, whereas 21 percentage of the respondents use shower as mode of bathing and 21 percentage of the respondents use tap water open till they take bath.
- 61 percentage of the respondents do not have rainwater harvesting, whereas 39 percentage of the respondents have rainwater harvesting.
- 41 percentage of the respondents reported that they pay tax, whereas 59 percentage of the respondents do not pay tax.
- 89 percentage of the respondents are satisfied with the water they receive, whereas 11 percentage of the respondents are not satisfied with the water they receive.
- 91 percentage of the respondents have access to safe water source for drinking, whereas 9 percentage of the respondents do not have access to safe water source for drinking.
- 41 percentage of the respondents always turn off water while brushing , whereas, 13 percentage of the respondents never turn off water while brushing
- 37 percentage of the respondents turn off water while shaving, whereas, 7 percentage of the respondents never turn off water while shaving.
- 49 percentage of the respondents turn off water while rinsing vegetables, whereas, 6 percentage of the respondents do not turn off water while rinsing vegetables.
- 45 percentage of the respondents often turn off water while rinsing clothes, whereas, 11 percentage of the respondents never turn off water while rinsing clothes.
- 42 percentage of the respondents turn off water while washing vessels, whereas, 9 percentage of the respondents do not turn off water while washing vessels

Conclusion

Water, the need of life, is likely to pose the greatest challenge on account of an increased demand with population rise and economic development, and shrinking supplies due to over-exploitation and pollution. Although water is an abundant and renewable natural resource covering two- thirds of the plant, a very small proportion of this is effectively available for the human use. In India, as a result of development, the demand for water is increasing both in urban and rural areas. This may increase tension and disputes over sharing and command of water resource. Responsible water usage at all levels and by all can be achieved by creating awareness through community board participatory approach.

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MULTIDIMENTIONAL IMPACT OF WATER TOWARDS ECONOMIC DEVELOPMENT

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Abstract

Water is essential to the health and wellbeing of the population and also sustains aquatic life. Countries rely heavily on water for irrigated agriculture, electricity generation, and to support other industries such as food processing, manufacturing and smelting. Consequently, the freshwater resources contained in rivers, lakes, reservoirs and groundwater aquifers can be one of a country's most valuable cultural, environmental, economic and strategic resources. In many countries, pressures on water resources are increasing with demand for water exceeding availability. Similarly, water quality in many water bodies is deteriorating. Countries that fail to tackle these issues effectively may find their future growth constrained. However, managing water resources is a complex undertaking. Water has public good dimensions. This means it is difficult to exclude potential users making water resources prone to over-exploitation.

Population and economic growth are putting pressure on available fresh water resources worldwide. Uncertain water availability is a challenge that many countries face, which can impact economic growth. This 'water challenge' has multiple dimensions, one of which is access to safe drinking water and basic sanitation services. Improved access has a direct positive impact on people and communities leading to significant social, economic and environmental benefits. Water resource management at river basins is another key link between water and economic growth. Effective management of freshwater resources helps sustain agriculture, industries, ecosystems and communities. On this backdrop this paper aims to highlight the multi-dimensional impact of water towards economic development.

Keywords: *Water, Economic Growth, Water Resources,*

Introduction

Water is essential to the health and wellbeing of the population and also sustains aquatic life. Countries rely heavily on water for irrigated agriculture, electricity generation, and to support other industries such as food processing, manufacturing and smelting. Consequently, the freshwater resources contained in rivers, lakes, reservoirs and groundwater aquifers can be one of a country's most valuable cultural, environmental, economic and strategic resources. In many countries, pressures on water resources are increasing with demand for water exceeding availability. Similarly, water quality in many water bodies is deteriorating. Countries that fail to tackle these issues effectively may find their future growth constrained. However, managing water resources is a complex undertaking. Water has public good dimensions. This means it is difficult to exclude potential users making water resources prone to over-exploitation.

Population and economic growth are putting pressure on available fresh water resources worldwide. Uncertain water availability is a challenge that many countries face, which can impact economic growth. This 'water challenge' has multiple dimensions, one of which is access to safe drinking water and basic sanitation services. Improved access has a direct positive impact on people and communities leading to significant social, economic and environmental benefits. Water resource management at river basins is another key link between water and economic growth. Effective management of freshwater resources helps sustain agriculture, industries, ecosystems and communities.

Water is an essential component of our economics and is at the centre of economic and social development. It is vital to maintain health, grow food, manage the environment and create jobs. There is a close link between water and economic growth of country. Lack of water is a barrier to sustainable socio-economic development, lack of development is a barrier to solving water problems. Water can affect basic human wellbeing and the productivity, scarcity of water, lack of collection and distribution systems can lead to extraordinary consumption of energy in gathering daily water needs. Domestic water supply serves as a basic component of welfare in its role as a direct consumer commodity, it also functions as an element of socio- economic infrastructure. Water contributes to a wide variety of natural productive process, including directly productive activities such as food production and manufacturing operations and as an element of basic economic infrastructure. Employment in the water sector remains relatively limited; the potential growth for jobs in

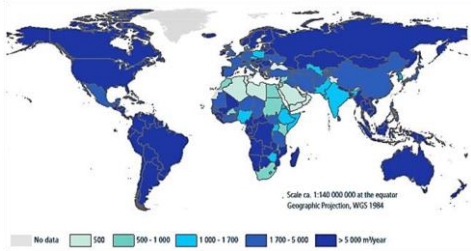
water sector is particularly changes from region to region. The water resources are limited in India, but growing demand of water due to increasing population, urbanization and industrialization. India's multidimensional water development has contributed significantly to the promotion of the country's economic growth.

The Global Perspective on Water

The world's freshwater resources renewed through a continuous cycle of evaporation, precipitation and runoff – commonly referred to as the water cycle – that dictates their distribution and availability over time and space. There are different ways of defineing and measuring water scarcity and/or water stress. The best-known indicator of national water scarcity is per capita renewable water per year, where threshold values used to distinguish between different levels of water stress (Falkenmark and Widstrand, 1992). An area or country is under regular water stress when renewable water supplies drop below 1,700 m3 per capita per year. Populations face chronic water scarcity when water supplies drop below 1,000 m per capita per year and absolutes.

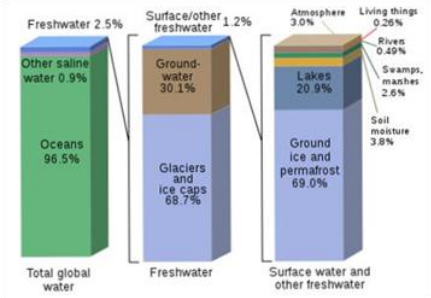
A. Scarcity below 500 m3 per capita per year. Using these thresholds, significant disparities exist between countries as shown below:

Figure 1. Total Renewable Water Resources (Cubic Meters Per Capita per Year), 2014



Source: The Global Perspective on Water, the United Nations Report 2016

Figure 2. Water Supply of the World



Source: Department of the Interior, Geological Survey, UNO, 2016

Water resources are sources of water that are potentially useful. Uses of water include agricultural, industrial, recreational and environmental activities. The majority of human uses require fresh water. 97% of the water on the Earth is salt water and only three percent is fresh water; slightly over two thirds of this is frozen in glaciers and polar ice caps. The remaining unfrozen fresh water found mainly as groundwater, with only a small fraction present above ground or in the air. Fresh water is a renewable resource, yet the world's supply of groundwater is steadily decreasing, with depletion occurring most prominently in Asia, South America and North America, although it is still unclear how much natural renewal balances this usage, and whether ecosystems are threatened.

Water and Economic Development at the National Level

The wealth of economics most often measured at the national level in term of Gross National Product, as index of the monetary rating of the economy often expressed as GNP per capita. There are also good measures of the water resources of nations. Thehuman development index (HDI) of the United Nations Development Programs attempts to express wealth in a broader context, aranking involving many social and economic factors. The key role, water plays in human development well accepted by all nations.

Human Development however should consider as an important contributor to the adequate management of water resources. The win-win situation can only achieved if the link between the two aspects understood and if this understanding is relates into integrated policies and programs. The term development indicates the progress, but the concept of Human Development used to focus on the ends rather than the means to achieve it. The real objective of development is to create an environment in which people have the possibility to enjoy a healthy and long life. Water is the basic and most important component of Human Development. The statistics for the wealth of nations in comparison with water or water availability there is generally weak correlation between the two factors.

USA, one of the world's richest countries in per capita GNP, is also one of the richest countries in terms of water availability, but water poor Germany and Japan also have a high per capita GNP. Whether Russia has low per capita GNP, but water availability is very high as compare to other selected countries shown in table. Water scare countries

like China, India and Bangladesh also have low per capita income as compare to other selected countries.

Water Resources and India

The water resources are limited in India, but growing demand of water due to increasing population, urbanization and industrialization. India is facing water stress. In water resources, due to contamination of treatment facility it is often difficult to get safe drinking water. India currently stores only 6 per cent of its annual rainfall or 253 cubic meters, while developed nations store 250 per cent of annual rainfall water. Nearly 15 per cent of food production is being produced using ground water resources in India. India's multidimensional water development has contributed significantly to the promotion of the country's economic growth. Rapid growth of irrigation and hydropower generation in last decade accelerates the economic growth of country. In India only 33 per cent population have access to clean drinking water. The problem is mostly contributed to a lack of government planning and extreme amounts of human wants.

Water Resources as a Bottleneck to Growth

There are some conditions, which can cause water to be a bottleneck to the growth process in economy. They are

1) When water inputs into production process fixed in relation to output
2) When water supply are fixed or only capable of slow and costly expansion
3) When supplies are rigidly allocated among uses over time
4) When water is a controlling factor in human wealth and productivity

Water is a fixed coefficient of the sort expressed in an input-output model, i.e. nothing can be substitutes for water nor can increases in efficiency be found to permit production to proceed with less water. Water can affect basic human wellbeing and the productivity, scarcity of water, lack of collection and distribution systems can lead to extraordinary consumption of energy ingathering daily water needs. It is less clear that under what conditions an improvement in water resources will lead to a significant improvement in productivity.

Addressing the Water Challenge

Competing demands for water and freshwater resources are increasing over time, due to population and economic growth. This 'water challenge' is the subject of attention of many stakeholders worldwide, from governments and international organisations, to multinationals, environmental groups, academia and NGOs. The 'water challenge' is multidimensional. Addressing the challenge will require improvements not only to populations' access to fresh drinking water and basic sanitation services – a basic human right - and improvements in the way we manage available fresh water resources in river basins; but also how efficiently and effectively we use freshwater resources in agriculture, industry, and household use; how we dispose of it after use, how we finance the investments required to improve water productivity, the inter-dependencies between water, food, energy and climate change, how we manage the risks and uncertainties inherent to the sector, and the potential for policy reform induced by increasing water scarcity.

Conclusion

India's multidimensional water development programs have contributed significantly to the promotion of the country's economic growth. Rapid growth of irrigation has substantially increased agricultural production. Hydro power generation has doubled during the last two decades, and this has accelerated industrialization and extended rural electrification. Minor irrigation has taken on a new importance in the Fourth Five Year Plan, signifying a departure from the earlier Plans. "Green Revolution" owes a large measure of its success to the availability of assured water supplies. Water development projects have also generated tremendous employment opportunities. Despite its pronounced impact on the economy, India's water planning strategy has some glaring weaknesses- the failure to incorporate "indirect benefits" in cost-benefit calculations, the under-utilization of water potential, and the progressive increase in the cost of irrigating an acre of land. The prevailing institutional structure in India constitutes a major deterrent to the diffusion of the benefits of water development.

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A CASE STUDY APPROACH TOWARDS WATER AND SANITATION ACCESSIBILITY AMONG WOMEN LIVING IN SLUMS OF TIRUPUR

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Abstract

India, since the opening up of its economy in the 1990s to the global economic opportunities, urban growth has seen the explosion of slums and homeless, challenging the policies and processes followed for bringing up the economic prosperity and human welfare. Slums, though poor, with its cheap and readily available labour, play a key role in the economic growth of the urban centres. They have been known for over-crowding, inadequate social amenities, poor educational attainment, larger unemployment, and insecurities in housing tenancies, all of which define their ecology. Most of the slums suffer from inadequate water supply and poor sanitation. Issues of water availability and Sanitation in terms of quantity and access are analyzed over time and space in the city of Tirupur for the current study as a case study. Using secondary data, a base for the study has been laid down, and also a slum profile of Tirupur city from Planning Commission Report has been taken as base for the entire study.

Keywords: *Urbanization, water accessibility, sanitation, women*

Introduction

Urbanization

Urbanization is a process of formation of towns and cities, which are the confluence of opportunities and people. The world has been witnessing a rapid urbanization in the last half-a-century or so. In the process, a predominantly rural culture has transformed into an urban culture (COHRE, 2008; Davis, 2006). In 2008, the population living in urban areas crossed the 50 per cent mark (Patel and Burke, 2009). Urbanization is an engine that energizes economic opportunities that accelerate innovations, social and economic development. Urban areas offer greater societal freedoms as well (CPRC, 2008).

Women and Urbanization

Women and men, and girls and boys, are variously affected by the conditions of urbanization and urban environment. For women, urbanization has unique causes and consequences. Women are "invariably disadvantaged compared to men in cities in terms of equal access to employment and shelter, health and educations, transport, asset ownership, experiences of urban violence and ability to exercise their rights. The world of a woman in an urban environment is characterized by the problems of her daily life: home-making and family care, getting to work, waiting for goods and services, protecting herself from physical dangers and diseases, suffering stress in the absence of domestic help, forming a social network, and preserving personal space and time when required. These disadvantages are especially marked for poor urban women" (UN-HABITAT, 2012b).

The stage at which a woman is in her lifecycle – whether she is a young girl, or a young woman with young children or an older woman – also makes a fundamental difference, as it determines her care responsibilities and her ability to combine these with paid work. It also largely defines her identity within the household as daughter, wife, mother or grandmother, each of which entails different gender relations.

Urbanization and Growth of Slums

As the global urban population grows, so does the population of the urban poor. Urban living is associated with higher levels of literacy and education, better health, greater access to social services, and enhanced opportunities for cultural and political participation. People, who look to improve their financial status or family standards, are often forced to migrate to cities so that they could live nearer the booming industries and job opportunities. Today, despite the comparative advantage of cities, the urban areas are more unequal than the rural areas and hundreds of millions of the world's urban poor live in sub-standard conditions.

Statement of the problem

Slums across the world there is a lack of basic infrastructure, shelter and services, the majority of the slums people live densely packed Shelters. Women's work

is essential for the survival of the urban poor and is especially high among the poorest households. At the same time, it is not a guarantee for moving out of poverty. Balancing paid work and care work remains one of the major constraints for urban women, and especially for the poor urban women. The cost of poor health, exacerbated by lack of sanitation and living in locations with high concentrations of environmental hazards, is also high. For them, missing a day's work means a considerable reduction in income, even if the pay is low. But, there are also huge costs for those who are responsible for unpaid care work. Poor housing conditions, distance from health services and schools, unsafe neighborhoods – because of environmental hazards and high rates of violence and crime, and limited access to water and sanitation places an additional burden on those who are responsible for child care, food preparation, cleaning and washing.

In this context the present study focuses both on urban setting and a gender approach. Women's use of resources, particularly of water and sanitation facilities in urban slums, is looked from a time-space perspective. .

Objectives of the study

- To assess the availability of and access to water and sanitation facilities among the slum women in the selected slums of Tirupur city.
- To study and analyze the impact of women's access to water and sanitation facilities in the selected slum areas.
- To identify the efforts of the Government towards overcoming the water and sanitation issues in the slums of Tirupur city.
- To suggest and recommend strategies for sustainable utilization of water and sanitation services in the slums of the city

Study Area and Methodology

The study is based on Tirupur city which has a population of 444,352 with a sex-ratio of 955 females for every 1,000 males, much above the national average of 929 (census 2011). The city has 27 slums out of total 87 slums in Tamil Nadu, where more than one third of the population live.

The study is based on Secondary data analysis which is obtained from governmental records, Tirupur Slum Analysis Report by Central Planning Commission surveys, district handbooks etc.

Review of Literature

The UN-HABITAT (2010) report highlights some of the key gender issues we face in the context of rapid urbanization in the developing world. It also provides an overview of UN-HABITAT's work in promoting gender equality in all its activities and programmes. The report highlighted that one in three people in cities of the developing world lives in a slum. Although conditions vary, research proved that women and girls often suffer the worst effects of slum life, such as poor access to clean water, inadequate sanitation and gender-based violence. On the whole, Governments and policy makers are still responding inadequately to different gender needs in towns and cities. Creating more equal opportunities and protecting rights for both women and men contributes to better living conditions for the urban poor a Sultana (2011) argues in a study of hers that resource access, use, control, ownership and conflict are not only mediated through social relations of power, but also through emotional geographies where gendered subjectivities and embodied emotions constitute how nature-society relations are lived and experienced on a daily basis. A case study of drinking water contamination from Bangladesh is used to develop the theoretical arguments in contributing to existing debates in political ecologies.

Crow (2001) talks about the modes of access to water and the social and technical conditions through which people gain command over water. There are three important points gained from the study. First, there is a broad contrast in access to water between the industrialized North and the non-industrialized South. Second, the diverse ways in which people gain access to water in the countryside of the Global South. Third, there are nd in achieving the Millennium Development Goals.

Findings of the Study

Accessing Water and Sanitation Facilities: on Gender Participation

- The study on the basis of report observed that Women of all age and girls were involved in fetching water and also in maintaining healthy and hygienic environment. Only a very few men, of about 8 per cent (average of four sample categories) have been involved in these activities.
- The study found out that 16 per cent of the residential slum households, 2 per cent of the

industrial slum households alone has individual water supply connections within their premises.

- The report highlighted that against the WHO standard of 75 persons sharing per water point, residential slums and resettlement colonies have 164 persons and 92 persons sharing per water point which indicates disproportional availability of facilities.
- The study identifies that there are women who are walking for more than 100 metres to fetch water in the slums. Nearly 61 per cent and 52 per cent of women in residential, industrial slums are travelling more than 100 metres to fetch water. While in resettlement colonies no women was found to travel more than 100 metres and about 59 per cent travel for the instance of about 51 metres to 100 metres to fetch water. A majority of the women in the slums walk to the water points to fetch water and carry the heavy weight of water containers over relatively long distances to home.
- A majority of the women in the industrial slums have been accessing water at morning timings while women of the residential slums have not been able to prefer any particular timing as their water supply time is uncertain.
- The seasonal difficulties are very high 55 percent in industrial slums as they are located in the peripheries where the water scarcity is predominant during summers.
- The study found the individual's impact on society through low productivity and less educational participation and poor social network among the slum community.
- The slum women have been making their choices of toilet services based on their availability, distance to and location of toilet, willingness to pay for access and also the maintenance and cleanliness of the latrines concerned. In many slums, the availability of the public toilet facilities has been minimal or not present at all, giving them no choice other than the open defecation. In the residential slums, there has not been any free toilet facility, but 24 per cent of the women have opted for 'pay and use' toilet and 57 per cent have been practicing open defecation. In the industrial slums, 6 per cent of the women have been using free public toilet and nearly 62 per cent have been practicing open defecation.
- The study on the basis of report found that the Tamil Nadu State Government is trying to implement all the national and other state schemes and policies effectively to reach the urban poor equally and to achieve its own vision of a prosperous state by 2023. Tirupur city comprises of huge population despite its small extension (space). Rapid urbanization due to textile growth has attracted inflow into the city for various reasons, leading to the pavement of booming of slums. The Government is taking steps to control the proliferation of new slums and upgrading the existing ones. Tirupur has always been a water scarce city and often faces problems of satisfying the water demand. The Government of Tamil Nadu has not laid any particular programme for the development of water and sanitation for the urban poor in the past decades but recently it has launched the "Tamil Nadu Vision 2023", which aims to develop water and sanitation facilities for the urban slum dwellers.
- The Government has been evicting large number of slum dwellers from the city to make way for new infrastructural projects and as a part of the city beautification projects. It was found around 20,000 households have been evicted from the city at various schedules between 2011 and 2016 alone, and more evictions have taken place since them (Transparent Chennai, Raman, 2012). The relocation of slum dwellers from objectionable places to some where away or far from the city has been impacting negatively on the livelihoods of slum people. The main issues raised by the relocated dwellers are about the lack of job opportunities in the new places and long distances to commute to their work places and schools and an extra expenditure on transportation, which has lead to stress in their daily lives.

Conclusion

Among many challenges confronted by slum areas, lack of access to improved water sources has arguably been the most enduring, problematic and important. Women have suffered disproportionately from inadequate

water and sanitation facilities. In the slums of Tirupur, not only women bear the burden of collecting water from standpipes or vendors, often queuing as early as 3 am to get just a fraction of their family's daily need, but they suffer considerably more from deficient sanitation facilities. Women are often forced to defecate in the open and, due to the stigma associated with this, they have to wait until after the dark, when they also face the risk of physical abuse. This list is of course incomplete and rudimentary, but it highlights the fact that, whether it is due to a gendered division of labour or the exclusion of women from the decision-making or the management of resources, women are disproportionately affected by the lack of access to adequate water and sanitation.

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EMERGING CONTAMINANTS AND EXTRACTION METHODS STRATEGY IN PULP AND PAPER INDUSTRIAL EFFLUENTS

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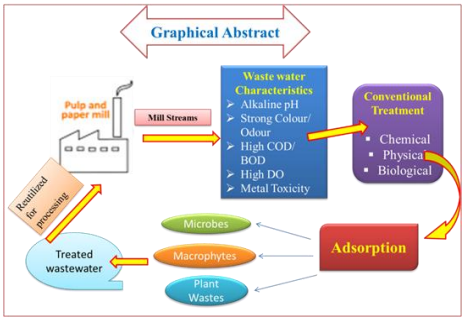
Abstract

Plenty of efforts have been put forth worldwide towards the environmental protection in recent years. The contribution of pulp and paper industries apart from their productions, significantly pollute water, air and soil through their direct and indirect discharges without adopting proper treatment technologies. Wastewaters from these industries possess large amounts of toxic inorganic moieties, exhibiting lesser biodegradability. The discharged effluents mark adverse impacts on human and environment. Many methods have been employed by researchers in treating these raw effluents let out from paper and pulp industries. This review discusses the advancement in research findings employing novel chelating methods for the contaminants like colour, BOD, COD, Suspended Solids, heavy metals from the aforesaid wastewaters, and also provides a baseline on environment protection initiatives in lieu of measures taken for creating a healthy environment.

Keywords: *pulp and paper industry, effluents, pollutants, environment*

Introduction



Industrial pollution has become a serious issue nowadays due to increasing demands of industries needed for the production of varied products in all means. Depending on the type of industry, the emission of pollutants may vary. Pulp and paper industries remain one of the main sources for releasing significant amounts of toxic pollutants into the environment. Generally, these industries consume raw materials like wood, bagasse, hemp, straw, etc., to produce paper, cardboards and other cellulose based products for processing. Pertinent sources of pollution among various stages of processing include wood preparation, pulping, pulp washing, screening, washing, bleaching and coating operation. Pulping processes are generally classified as chemical, mechanical or semi-chemical. Amongst the processes, chemical pulping is used for commercial manufacture of papers. This in turn, generates wastewater containing wood debris and soluble wood materials whereas pulp bleaching leach out toxic substances like chlorine utilized for brightening the pulp. Major chemicals employed during bleaching process are inclusive of sodium sulphate, sodium hydroxide, sodium carbonate, calcium hypochlorite and sodium bisulphite. These bleaching salts form the basis of coloured effluents with lignin and derivatives of lignin[1]. Practically, major portion of the effluents emanating are discharged directly into the nearby rivers or lakes or emptied into barren land. Obviously, the non-biodegradable substances present alter the soil pH, thereby the soil characteristics and affect the aquatic environment[2]. Subsequently, the occurrence of bleaching chemicals reflects on water temperature, declined photosynthesis, both leading to decreased concentration of dissolved oxygen. This article specifies the manufacturing processes practised in the pulp and paper industry, downsides of contaminating effluents to the natural sources directly from the industry and the abstraction methods practised as alternates.

Table 1 Toxic Effects of Heavy Metals

Metals	Toxic Effects
Chromium[3]	Allergic reactions(skin rash), Nose irritations, Nosebleeds Respiratory problems, Weakened immune systems, Kidney and liver damage, Lung cancer, Ulcerations, Dermatitis
Copper[3]	Reproductive and developmental toxicity, neurotoxicity, and acute toxicity, dizziness, diarrhoea
Mercury[3]	Nervous system, Mental retardation, Cerebral palsy, Convulsions, Pulmonary function and Kidney dyspnoea
Nickel[6]	Cancer of lungs, Headache, Dizziness, Nausea and vomiting, Chest pain, Tightness of the chest, Dry cough and shortness of breath, Rapid respiration, Cyanosis and Extreme weakness
Lead[3]	Anaemia, brain damage, anorexia, malaise, loss of appetite
Zinc[3]	Short term "metal-fume fever," gastrointestinal distress, nausea and diarrhoea

Pulp and Paper Effluent Characteristics

Effluents of pulp and paper industries are found to possess pH, colour, suspended solids, dissolved solids, BOD and COD parameters greater than the prescribed limits. The discharged effluents may have a chance of altering the aquatic ecosystem through variation in physico – chemical parameters.

Hydrogen-ion concentration is an important water quality parameter of wastewaters. If there is change in the pH value, the qualities of water and soil get affected. The aforesaid effluents exhibit alkaline pH due to the excess usage of bleaching chemicals employed during processing. Colour component is an important parameter, as it is an indicator of contaminant level. Higher concentrations of suspended solids and dissolved solids reduce water clarity and also inhibit the process of photosynthesis. Excess demands for biological and chemical oxygen leads to suffocation of aquatic organisms. Heavy metals present in the discharged effluents lead to their bioaccumulation in the food chain. Water resources polluted by toxic metals when employed for irrigation purposes indirectly promote reduced yield, impaired growth and crop damages.

Heavy Metals - Toxicity

The presence of heavy metals in aquatic environment is known to cause severe damage to aquatic life, besides the fact that these metals kill microorganisms during biological treatment of wastewater with a consequent delay of water purification process. Heavy metal toxicity can result in reduced mental and central nervous function, damage to blood composition, lungs, kidneys and other vital organs. At higher doses, heavy metals can cause irreversible brain damage. Several disasters of metal poisoning episodes have been reported from time to time, which have resulted in great ecological damage with a large number of human causalities. Heavy metals present by and large in the pulp and paper industrial effluents and their toxic impacts are listed in Table 1.

Impact of Effluents in Water Quality

The environmental impact of this industry is of particular concern since these units generate 150-200 m^3 effluent/ton paper with a high pollution loading of 90-240 kg suspended solids/ton paper, 85-370 kg biochemical oxygen demand (BOD)/ton paper and 500-1100 kg chemical oxygen demand (COD)/ ton paper. The pollution load of these industries in Tamil Nadu, particularly in cauvery river basin is estimated as 5349 kg/ day after processing. These disposal wastes lead to deoxygenation of river. Similarly, settling of pulp fibres and sludge disposal to a depth of 1 meter in the river bed from Seshayee Pulp and Paper Board, Pallipalayam demands concern

Environmental Standards and Discharge Norms for Pulp and Paper Industry

The Central Pollution Control Board has taken several initiatives for reducing the pollution in water bodies by 2020. The notable step-up by CPCB initiative is not to allow discharge of any untreated industrial effluent in the water sources. The present environmental standards and discharge norms for Tamilnadu paper industry are listed in Table 2.

Table 2 EPA Standards for Pulp and Paper Industrial Effluents

S.No	Industry	Parameter	Standards
	Small Pulp and Paper Industry		
1.	Discharge	pH Suspended solids BOD COD	5.5 – 9.0 100 ppm 30 ppm 100 ppm
	Large Pulp and Paper Industry		
2.	Discharge	pH Suspended solids BOD COD	7.0 - 8.5 100 ppm 30 ppm 350 ppm
3.	Pulp and Paper Industry	Pb Cu Cr Zn	0.1 ppm 3.0 ppm 0.1 ppm 5.0 ppm

Need for Treatment

Gallons of water are employed in the manufacturing of paper products which in turn discharge the huge volumes

of wastewaters in addition to sludges being disposed. The colour of these wastewaters discharged into water resources has become an important issue. Fine and coarse particles, organo – chlorine compounds, sulphur compounds, volatile organic compounds are emitted after the production process. Other toxic contaminants of pulp and paper industry include chlorinated compounds, lignin and metals. These serve as an immediate danger when let out as such into the environment. Physical, chemical and biological methods of analyses are carried out to study the characteristics of the effluents. An important strategy for effluent treatment lies in the designing of processes pertaining to specific environment waste matrixes concerning sustainable growth.

Effluent Treatment - Conventional Methods

Over the last few decades, several methods have been designed to treat pulp and paper industrial effluents which have been divided under physical, chemical and biological processes. Commonly used physical and chemical treatment methods are electrocoagulation, ultrasound, reverse osmosis, photo catalytic systems using titanium dioxide (TiO_2) and zinc oxide (ZnO) under UV/solar irradiation , hydrogen peroxide, Fenton's reagent (H_2O_2/Fe^{2+}), UV,UV/ H_2O_2, Photo-Fenton (UV/ H_2O_2/Fe^{2+}),ozonation and peroxon (ozone/H_2O_2). Few studies have optimized the operating conditions for the effluent treatment. Biological treatment methods employed involves the utilization of fungi, bacteria, algae and enzymes as a single step treatment or in combination with other physical and chemical methods. Though, currently used methods possess several limitations in the removal of contaminants from effluents, such methods revealed non-economic and feasible properties for the treatment at even low concentrations. Table3 illustrates the benefits and drawbacks of these conventional techniques for the removal of contaminants.

Table 3 Merits and Demerits of Conventional Methods

Conventional Methods	Merits	Demerits
Physical[4]	Physico–chemical parameters, selective process	Costly, consumption of chemicals, Disposal problems
Chemical		
Biological	Uses several classes of microorganisms- to degrade the polymeric lignin derived chromophoric material.	Successful removal of colour from the waste water

Adsorption classified under physical method of treating effluent discharges has been explicitly adopted as a promising technology because of its simplicity, profitability, ease of operation and efficiency. A comparative study involving this technique by various authors is represented in this review paper. Several reports with detailed proceedings have been put forth for the effective removal of contaminants present in pulp and paper industrial effluents using adsorbents such as Saccharomyces sp., Corn cob, Plantain Stalk, Water hyacinth, *Azollacaroliniana*, *Bacillus subtilis*, Mango plant leaves.

Microbes as Adsorbents

Saccharomyces, Aspergillus, Bacillus species implied a broad range of metal accumulation indicative of their capability to bind heavy metals present in the effluents. Significant reduction of Cd, Zn and Pb metals through inoculation with *Aspergillus.niger* and *Aspergillus.flavus*[6] biomass were reported using untreated paper industry effluent. Strains of *Bacillus subtilis*[7] isolated from sediment core were employed for the removal of Zn^{2+} and $Pb^{2+}$from Paper mill in an indigenously designed Bench-Top Bioreactor. The results confirmed that the species were more effective in trapping Zn^{2+} and Pb^{2+} from the paper mill effluent under optimum conditions. Saccharomyces species were examined for the removal of lead, chromium, copper, nickel, zinc and cadmium present in the effluent.

Macrophytes as Adsorbents

Water hyacinth was investigated as a biosorbent for the removal of Zn (II) and Pb (II) ions from paper industry effluent. Furthermore, it was reported that COD and colour removal efficiency was high with activated water hyacinth as adsorbent material. In addition, water hyacinth based activated carbon possessed high surface area to extract the metals form the effluent. The potential to accumulate metals like iron, nickel, manganese and copper by Trapa bipinosa[8] was assessed by subjecting to different effluent concentrations of pulp and paper industry, where it was found to be outstanding in assimilating heavy metals. Physico – chemical parameters such as TDS, BOD and COD in a paper mill effluent was effectively decreased by using Azolla caroliniana as adsorbent at varying dilution ratios, biomass and pH. The studied results using Azolla caroliniana[9] has proven to maintain a balance of physico – chemical parameters. Recently, extensive studies on physico –chemical parameters have been carried out with respect to APHA method. Several aquatic macrophytes

such as Eichornia, Pistia and Salvinia were observed to scavenge inorganic and organic compounds from wastewaters. Ipomea aquatica showed good Cr(VI) scavenging ability from contaminated waste effluent.

Plant Based Materials as Adsorbents

Employments of plant – based wastes as adsorbent materials have been thoroughly verified for pollution abatement. The suitability of locally available corn cobs and plantain stalks[10] in the adsorption of Pb and Ag from pulp and paper industry effluent using batch technique was investigated. Many researchers reported the relation between the presence of various functional groups and their complexion with heavy metals during biosorption process. A number of studies have highlighted the potential use of inexpensive materials prepared from plant based substances as effective metal sequestrants. Mango plant leaves[11] were utilized in the removal of zinc, lead and cadmium from paper industry which revealed its maximum adsorption potential. Plant analysis revealed that maximum uptake and concentration of the heavy metals was found in 50% concentration. This statement is supported by the findings of Srivastava where Spirodela is employed for copper removal. A comparative data of the aforesaid discussions for specific metals are listed in Table 4.

Table 4 Percentage Removal of Parameters amongst the Chosen Adsorbents

Adsorbent		Industry / Area	Parameters	Removal (%)
Microbes	Saccharomyces	Bhadravathi	Cd, Pb, Ni, Cr, Zn, Cu	52, 45, 43, 41, 38, 37
	Aspergillus (A. niger & A. flavus)	Bhadravathi	Pb, Zn, Cu, Ni	75, 49, 45, 25, 82, 40, 34, 18
	Bacillus (*Bacillus spp.* & *Bacillus subtilis)*	Star Paper Mill Ltd., Saharanpur city (U.P.)	Zn, Pb	73, 85, 78, 87
Macrophytes	Water Hyacinth	Uttaranchal	Zn, Pb	73, 80
	Azolla Caroliniana	Karur	TDS BOD COD	82 88 79
	Trapa bipinosa	Mysore Paper Mills Ltd., Bhadravathi	COD Ni	50 73
Plant - Based	Corn Cob & Plantain Bunch Stalk	Nigeria	Pb, Ag	53, 46 54, 44
	Cassia obtusifolia seed gum	Board and Paper Mill, Kajang, Malaysia	TSS COD	86 36
	Manga Plant Leaves	Pune	Pb Cd Zn	30 32 26

Conclusion

Enormous research studies have been carried out using adsorption technology. nnumerous research groups continue working on intensive experiments to exploit economical eco-friendly materials to be exploited for the removal of contaminants and in water treatment before being discharged into the environment. The tabulated results envisaged the utilization of macrophytes (*Azolla Caroliniana*) as better sorbent in the reduction of TDS, BOD and COD, whereas microbes (*Bacillus Sp.*) registered a marked influence in the removal of heavy metals against other studied novel materials. This review article shall probe the researchers to develop and modeify novel adsorbent materials towards degradation of the pulp and paper waste leachates, the challenge lying in the selection of bio compatible materials.

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EFFECTIVE WATERSHED MANAGEMENT: PROBLEMS, MEASURES AND PRACTICES

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Abstract

Watershed management is developing these days due to economy development and the need for resources in the environment development. Watershed management which it helps in conserving water as well as helps in perversion of rain water harvesting by which it provides a rise in ground water level which again provides a way to improve the resources. Due to it prevents soil erosion based on certain climate condition. In this study it deals with the certain problems and the measures that are related to the watershed management and the factors that affect them regarding those characteristics (biological factors) and some of the practices that have been followed in watershed management.

Keywords: *watershed management, soil erosion, conserving water, ground water level.*

Introduction

The ecosystem tends to become fragile and precariously balanced due to rapid increase in human and bovine population, over exploitation of natural resources to meet their food, fodder and fuel requirement and unscientific management of these resources. The effective conservation and management of land, water and vegetation resources aimed at obtaining optimum and sustained return from these resources without degrading them can be achieved by adopting watershed as basic unit of development. Watershed being a natural hydrological entity, it responds most effectively to various engineering, biological and cultural treatments. Monitoring of runoff and silt at the outlet of the watershed can help assess the impact of various treatments aimed at conserving soil and water, and protecting vegetation.

Every body of water (e.g., rivers, lakes, ponds, streams, and estuaries) has a watershed. The watershed is the area of land that drains or sheds water into a specific receiving water body such as a lake or a river. As rainwater or melted snow runs downhill in the watershed, it collects and transports sediment and other materials and deposits them into the receiving water body. Watershed management is a term used to describe the process of implementing land use practices and water management practices to protect and improve the quality of the water and other natural resources within a watershed by managing the use of those land and water resources in a comprehensive manner. The main purpose of a watershed is an area of land that drains rain water or snow into one location such as a stream, lake or wetland. These water bodies supply our drinking water, water for agriculture and manufacturing, offer opportunities for recreation and provide habitat to numerous plants and animals.

Objectives of watershed management

The different objectives of watershed management are:

1. To control damaging runoff and degradation and thereby conservation of soil and water.
2. To manage and utilize the runoff water for useful purpose.
3. To protect, conserve and improve the land of watershed for more efficient and sustained production.
4. To protect and enhance the water resource originating in the watershed.
5. To check soil erosion and to reduce the effect of sediment yield on the watershed.

Advantages

Watershed management emphasizes scientific soil and water conservation in order to increase the biomass production. These are few advantages of watershed management.

- The main aim is to develop primary resources of land and water.
- To produce secondary resources of plants and animals for use in a manner this will cause ecological imbalance.

- Watershed management not only increases the production and income of the watershed community, but also mitigates droughts and floods and increases the life of the downstream dam and reservoirs.

Watershed Management Planning

Watershed management planning is a process that results in a plan or a blueprint of how to best protect and improve the water quality and other natural resources in a watershed. Very often, watershed boundaries extend over political boundaries into adjacent municipalities or states. A comprehensive planning process that involves all affected municipalities located in the watershed which is essential to make a successful watershed management.

Steps in Watershed Management Planning

- Inventory and map the resources in the watershed;
- Inventory and map the natural and manmade drainage systems in the watershed;
- Identify areas of erosion, including stream banks and construction sites;
- Identify the quality of water resources in the watershed as a baseline; and
- Inventory and map pollution sources, both point sources (such as industrial discharge pipes) and nonpoint sources (such as municipal storm water systems, failing septic systems, illicit discharges).
- Delineate and map the watershed's boundaries and the smaller drainage basins within the watershed.

Types of Watershed

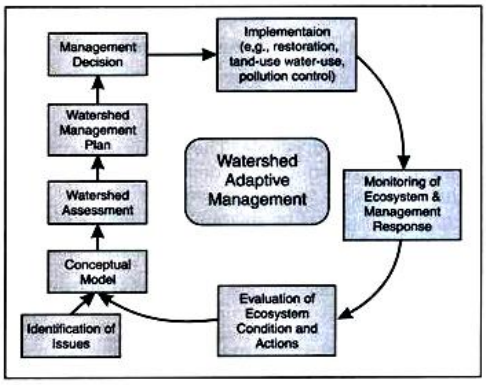
- Macro watershed (> 50,000 Hect)
- Sub-watershed (10,000 to 50,000 Hect)
- Milli-watershed (1000 to10000 Hect)
- Micro watershed (100 to 1000 Hect)
- Mini watershed (1-100 Hect)

Factors Affecting Watershed Management

All characteristics that affect characteristics of watershed management.

- **Size:** It helps in computing parameters like precipitation received, retained, drained off.
- **Shape:** Different shapes based on morphological parameters like geology and structure
- **Physiographic:** Lands altitude and physical disposition.
- **Slope:** It controls the rainfall distribution and movement:
- **Climate:** It decides the quantitative approach.
- **Drainage:** It determines the flow characteristics and so the erosion behavior.
- **Vegetation:** Information of species gives a sure ground for selection plants and crops.
- **Geology and Soils:** The nature determines size, shape, physiographic, drainage and groundwater conditions. Soils, derivative of rocks are the basic to greenery
- **Hydrology:** Basic to final goal of growing greenery in a watershed. It helps in quantification of water available.
- **Hydrogeology:** Availability of groundwater.
- **Socioeconomics:** Statistics on people and their health, hygiene, wants and wishes are important in managing water.

These factors determine temperatures, humidity, wind, precipitation and evaporation in a watershed. Weathering factors, such as rain, snow, wind, glaciers and temperature changes, erode soil and rock formations and change the topography of the watershed.



Watershed Adaptive Management

Problems Associated with Watersheds

- Flooding
- Unstable Slopes / Land Slides
- Erosion from Denuded Land
- Deficient Water Supplies

- Energy Shortage
- Food Shortage
- Poor Quality Drinking Water
- Polluted Streams / Reduced Fishing

Watershed Management Measures

Watershed can be managed by using some of the measures to prevent the following.

Water Preservation / Enhancement

- Flood Peaks/River flows
- Groundwater Recharge
- Sediment loads
- Pollutants

Vegetation Preservation/ Enhancement

- Bio mass Quantity
- Bio mass Quality

Soil Preservation/Enhancement

- Erosion
- Structural Status
- Biological

Watershed Management Practices

1. The interims purpose of watershed management
   - To increase the infiltration.
   - To increase the water holding capacity.
   - To prevent soil erosion.
2. Method and accomplishment

   Some of the watershed management and structures
   - **Broad beds and furrows**

     a) Function -To control soil erosion and conserve soil moisture in the soil during rainy days.

     b) It is laid in the fields using animal drawn or tractor drawn ridgers.

     c) Features – The main feature is to conserve soil moisture and controls soil erosion during rainy days.

- **Contour bund**

  a) Function – To intercept the run off flowing down the slope by an embankment.

  b) It helps to control run off velocity.

  c) Features – It can be adopted on all soils and helps to retain soil moisture.

- **Bench terracing**

  a) Function – It helps to bring sloping land into different level strips to enable cultivation.

  b) It consists of construction of step like fields along contours by half cutting and half filling.

  c) Features – it is suitable only for hilly regions and the benches may be inward sloping to drain off the excess water.

- **Micro catchment for sloping land**

  a) Function – It is useful for moisture conservation and erosion control for tree crops.

  b) It is suitable for light to moderate texture soil type and for moisture conservation with staggered planting.

  c) Feature – It is suitable for dry land horticulture and agro forestry.

- **Check dam**

  a) Function – It is useful in storing water which improves soil moisture of the adjoining.

b) It cuts the velocity and reduces erosive activity.

c) Features - Spacing between the check dams water spread of one should be beyond the water spread of the other.

Some of the suggestion which will help to keep clean and healthy watershed management.

- Use hardy plants that require little or no watering, fertilizers or pesticides in your yard.
- Do not over apply fertilizers. Consider using organic or slow release fertilizers instead.
- Use surfaces like wood, brick or gravel for decks & walkways; allows rain to soak in & not run off.
- Never pour used oil or antifreeze into the storm drain or the street.
- Drive less, walk or bike, many pollutants in our waters come from car exhaust and car leaks.

Conclusion

Watershed management is important to balance the economic and environment and to preserve the ground water level and to protect the soil from erosion. Watershed management which it helps to improve the water resources effectively for agriculture purpose as well as for economic development usually water comes from rainfall which helps conserving rain water harvesting and safe water for future usage. So we need to remember that our everyday activities that may affect the water level due to watershed management it helps to use water resources in an effective manner.

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INTERLINKING OF RIVERS IN INDIA – PROSPECTS AND CHALLENGES

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Abstact

The National River Linking Project (NRLP) envisages transferring water from the surplus river basins to ease the water shortages in western and southern India while mitigating the impacts of recurrent floods in eastern India. NRLP constitutes two basic components — the links which will connect the Himalayan rivers and those which will connect the peninsular rivers. This article discuss about the prospects and challenges of national river linking project.

Keywords: *Water, River Linking Project*

Introduction

Water is undoubtedly the most important natural resource on the planet, as it sustains all aspects of life in a way that no other resources can. United Nations agencies and the World Bank have claimed that the water scarcities will escalate in the future, create serious problems for human mankind and the environment. India needs to adopt a crystal- clear water mission that can help us to use available water resources to field, villages, towns and industries round the year, without harming our environment (Mehta and Mehta 2013).

A large spatial variation exists in the availability of water resources in the different basins of India (Amarasinghe et al. 2005). India is a vast country and its water availability varies significantly across regions and river basins. Water is in plenty in the north-eastern region, but few people live there and food production is low. In the north-western region most of the water resources are diverted for crop production, to such an extent that this region supplies food to the food deficit regions of the country, making it the largest provider of virtual water, that is, the water embedded in food. Water is scarce in the southern and western parts of the country, as the naturally drier areas come under increasing demand. Recurrent floods in the east and droughts in the south and west compound water related challenges that India is facing today. All indications are that India is heading towards a turbulent water future (World Bank 2005)

For a long period of time, the notables in India have argued that the answer to the drought-proneness of western and peninsular India lies in the flood-proneness of the east, and vice versa. Sir Arthur Cotton, who restored the Grand Anicut on the Cauvery and has remained a cult figure in the Deccan villages since the early decades of the nineteenth century, had thought of a plan to link the rivers in southern India for inland navigation. More recently during the mid-1960s, Dr K.L. Rao, a well-respected technocrat, presented a crude proposal for a Ganga-Cauvery Link from a point below Patna. A few years later, Captain Dastur, a pilot, speculated aloud about a lateral Himalayan canal from the Ravi to the Brahmaputra along a constant 400-meter contour interconnected with a Garland Canal girdling peninsular India. But ideas like the Garland canal and the Ganga-Cauvery Link were routinely dismissed as too grandiose for a resource-strapped nation. The Indian psyche was, however, never fully disassociated with the idea; Prime Minister, Mrs. Indira Gandhi constituted the National Water Development Agency (NWDA) to start detailed planning of a mega-project, which no one imagined would ever leave the drawing board (Tushaar Shah).

Capt. Dastur Proposal (1977) envisaged construction of two canals – the first 4200 km. Himalayan Canal at the foot of Himalayan slopes running from the Ravi in the West to the Brahmaputra and beyond in the east; and the second 9300 km Garland Canal covering the central and southern parts, with both the canals integrated with numerous lakes and interconnected with pipelines at two points, Delhi and Patna.

River-linking project

The sheer scale and scope of the project: 30 river linkages and more than 3,000 storage structures spread across a 15,000km canal network that will transfer 174 trillion litres of water every year, and will cost a total of Rs5.6 trillion. This puts the river-linking project on a par with some of the most daring feats of engineering attempted in the history of mankind. It is a reimagining of

the entire aquatic ecosystem of a country as large and diverse as Indi (IUCN 2003)

The Indian Rivers Inter-link aims to link India's rivers by a network of reservoirs and canals and so reduce persistent floods in some parts and water shortages in other parts of India. The Inter-link project has been split into three parts: a northern Himalayan rivers inter-link component, a southern peninsular component and starting 2005, an intrastate rivers linking component. The project is being managed by India's National Water Development Agency (NWDA), under its Ministry of Water Resources.

The idea to link rivers got a shot in the arm with the establishment of the National Water Development Agency in 1982 by then Prime Minister Indira Gandhi. The first National Democratic Alliance government (1999-2004) was keen to implement the interlinking of rivers (ILR) project, and the Supreme Court, following public interest litigation, in 2003, asked for it to be implemented by 2016.

Component of National River planning project

Connect the Himalayan and peninsular rivers via a network of canals so that excess water from one channel can be diverted to another which has inadequate flow. The interlinking of rivers has two components: the Himalayan component and a peninsular one. All interlinking schemes are aimed at transferring of water from one river system to another or by lifting across natural basins. The project will build 30 links and some 3000 storages to connect 37 Himalayan and Peninsular rivers to form a gigantic South Asian water grid. The canals, planned to be 50 to 100 meters wide and more than 6 meters deep, would facilitate navigation. The estimates of key project variables - still in the nature of back-of-the-envelope calculations - suggest it will cost around US $ 123 billion (or Indian Rs 560,000 crores, at 2002 prices), handle 178 km of inter-basin water transfer/per year, build 12,500 km of canals, create 35 giga watt of hydropower capacity, add 35 million hectares to India's irrigated areas, and create an unknown volume of navigation and fishery benefits. Similarly, 3700 mega watt would be required to lift water across major watershed ridges by up to 116 meters. The majority of observers agree that the Project may not be in operation even by 2050.

Himalayan Component

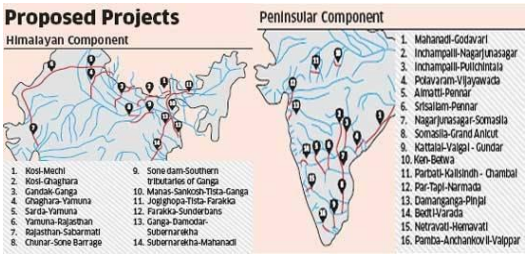
- The Himalayan component envisages construction of storage reservoirs on the main Ganga and Brahmaputra Rivers and their principal tributaries in India and Nepal so as to conserve monsoon flows for irrigation and hydro-power generation, besides flood control.
- Links will transfer surplus flows of the Kosi, Gandak and Ghagra to the west.
- In addition, the Brahmaputra-Ganga Link will augment dry-weather flow of the Ganga.
- Surplus flows that will become available on account of inter-linking of the Ganga and the Yamuna are proposed to be transferred to the drought prone areas of Haryana, Rajasthan and Gujarat.
- It would also provide 1120 cumec to Calcutta Port and would provide navigation facility across the country.
- It will also provide flood moderation in the Ganga-Brahmaputra system.
- The Himalayan component will benefit not only India but also Nepal and Bangladesh.
- Fourteen links are proposed in the Himalayan component.

Peninsular Rivers Development Component

- The main component of Peninsular Rivers Development is the "Southern Water Grid" which is envisaged to link Mahanadi, Godavari, Krishna, Pennar, and Cauvery rivers. The peninsular scheme was envisaged to provide additional irrigation benefits of over 13 million ha. The Peninsular component comprises the following four parts:
- Diversion of surplus flows of Mahanadi and Godavari to Krishna, Pennar, Cauvery and Vaigai.
- Diversion of west-flowing rivers of Kerala and Karnataka to the east.
- Inter-linking small rivers flowing along the west coast, north of Mumbai and south of Tapi.
- Inter-linking the southern tributaries of Yamuna.
- The peninsular component of ILR has 13 major water storage/diversion structures situated in four basins. Three non-storage structures, viz., Dowlaiswaram barrage, Prakasam barrage, and Grand Anicut and storage node (Narayanpur) cater to only irrigation, while six storage nodes, viz., Inchampalli, Almatti, Nagarjunasagar, Pulichintala, Krishnarajasagar, and Mettur will serve both irrigation and power needs.
- One storage node, viz., Somasila is operated to meet domestic and irrigation needs and two

storage nodes, viz., Polavaram and Srisailam are multi-purpose projects serving domestic, irrigation, and hydropower demands.

Source: www. www.researchgate.net.com



Source: www.economictimes.indiatimes.com

Advantages of the project

- Problems related to flood control, irrigation, limiting droughts and boosting farm output—can be sorted out by linking the country's rivers.
- Potential benefits to transport infrastructure through navigation, as well as to broadening income sources in rural areas through fish farming.
- Provide additional irrigation to 35 million ha of crop area and water supply to domestic
- and industrial sectors; add 34 GW of hydro-power potential to the national grid; mitigate floods in eastern India; facilitate various other economic activities such as internal navigation, fisheries, ground water recharge, environmental flow of water-scarce rivers etc.

Disadvantage of the project

- It will lead to massive displacement of people
- Since the Ganga basin's topography is flat, building dams would not substantially add to river flows and these dams could threaten the forests of the Himalayas and impact the functioning of the monsoon system.
- The transfer of such enormous amounts of water will inundate forests and land for reservoirs, and the weight of billions of litres of water may even have seismic implications in the Himalayan region.
- River inter-linking is an expensive business from building the link canals to the monitoring and maintenance infrastructure. Implementation of the project not only needs a huge financial capital but also political support, both are scarce commodities as of now.
- Another important issue is building consensus among states and Land acquisition.
- Once the project is implemented it would lead to large scale displacement of people and animals. Hence appropriate rehabilitation measures should be taken by the Government.
- A careful scientific assessment of the project and its impact on the environment, is necessary in case of a project of this magnitude especially with regard to Biodiversity
- A north to south inter-linking of rivers is physically not possible. The barrier imposed by the Vindhya Mountains makes it expensive to lift water along the north and south axis. It is also unnecessary.
- Henceforth, the river-water linking plan – one for peninsular India and the other for linking rivers from the east to the north is an ideal solution.

Critics

- The project is built on bad science and an outdated understanding of water systems and water management.
- Specifically, the concept of surplus and deficit river basins—which is at the core of the river-linking project—is contested.
- A new study by researchers at the Indian Institutes of Technology in Mumbai and Chennai, analyzing weather data over 103 years (from 1901 to 2004), has found that rainfall has decreased over the years by more than 10% even in river basins that once had a surplus, such as those of the Mahanadi and the Godavari.

- The project seems to view the river as a uni-dimensional water pipeline when it is, in fact, an entire ecosystem—and any changes to its natural course will have an impact on all the flora and fauna, the wetlands and the floodplains that are intricately linked to the river system.
- The long-term environmental impact of such a project is a major concern.
- For example, one of the reasons why the Ken-Betwa link, which is now receiving priority attention, has been stuck for several years is because it requires environmental clearance for diverting 5,500 hectares from the Panna National Park, a tiger reserve.
- Less than positive experience other countries have had with such projects—be it the Soviet regime's decision to divert the Amu Darya and the Syr Darya, which fed the Aral Sea, to irrigate the desert, or the Australian government's experiments in its Murray Darling basin.
- Water transfer and water sharing are sensitive subjects that have already spawned century-long disputes.
- Moreover, water is a state subject in India, and even though the Centre is empowered to bring an inter-state river under its control to serve the national interest, it has effectively never done so owing to enormous resistance from the states.

Conclusion

The transfer of water from abundant rivers to water-deficit areas will lead to adequate supply for everyone in every part of the country. It also appears to promote national integration and a fair sharing of the country's natural water wealth. India's river link project shows and promises a great concern for water conservation and optimum use of available water resources. Apart from the positive aspects of river link project there are problems in providing domestic water supplies in areas away from the river which are largely remain unsolved and there are no official figures available for the number of people to be displaced.

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ROLE OF WATER IN THE PROGRESS OF INDIAN SOCIETY

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"Water is the lifeblood of our bodies, our economy, our nation and our well-being" - Stephen Johnson

Abstract

Water is an essential part of Hindu philosophies and customs and it is always given a sacred position in the centuries-old civilization of India. The civilization originated and flourished on the banks of the sacred rivers and the influence of the rivers is reflected in all aspects of human life. The importance of water is often highlighted in the ancient records show the awareness existed in India on water conservation and management. This paper is a review on the role of water in the progress of society in India in religious, traditional, and technological practices.

Introduction

As in many other parts of the World, civilization in India also flourished around rivers and deltas, and rivers remains as an enduring symbol of national culture. Different generations have considered rivers as sacred. The seven important rivers the Ganges, Yamuna, Godavari, Saraswathi, Narmada, Indus and Cauveri cover the length and breadth of the entire nation, and connect people with different lifestyles, dialects, costumes, etc. Ancient civilization, at Mohenjo-Daro and Harappa in the Indus Valley, started around 4000-5000 BC. Excavations at these sites, scattered information in the old literature, and studies of the truth behind religious practices provide an idea about the role that water played in the rich cultural heritage.

Water in civilization

The Indus Valley civilization, one of the earliest civilizations, was the world's largest in extent. Its total area covered 1 x 106 km^2, comprising north India and the present Pakistan. The first major settlements in the civilization based on Mohenjo-Daro and Harappa, were found along the Indus River and its tributary, the Ravi. Study in recent decades has revealed several sites along the dry bed of a huge river, now widely recognized as the legendary River Saraswati. Satellite images also show signs of channels of water in northern and western India that disappeared long ago. Urban centres were usually planned near rivers or at the coast. The great and well planned cities provided public and private baths, sewerage through underground drains built with precisely laid bricks, and an efficient water management system with numerous reservoirs and wells. In the impressive drainage systems, drains from houses were connected to the larger public drains. Agriculture was practiced on a wide scale, with extensive networks of canals for irrigation. It appears that fire and flood control measures to protect farms and villages were also practiced.

Water management and technologies

Drier climates and water scarcity in India led to numerous innovations in water-management techniques, since the Indus valley civilization. Irrigation systems, different types of wells, water storage systems and low cost and sustainable water-harvesting techniques were developed throughout the region. The reservoirs built in 3000 BC at Girnar, the artificial irrigation lake Bhojsagar in Madhya Pradesh constructed in the 11th century, the artificial lake fed by the Kaveri River in the same century and ancient step-wells in Western India are examples of some of the skills. Technologies based on water were also prevalent in ancient India. Reference to the manually operated cooling device "variyantra" revolving water spray for cooling the air is given in the centuries old writing "Arthashastra" of Kautilya, 400 BC. The "Arthashastra" and "Astadhyayi" of Panini, 700 BC, give reference to raingauges.

Water in beliefs and religious practices

The physical and aesthetic properties of water give it a unique mythical religious potential and therefore it has played an important role in myths and religious rituals. Lord Vishnu, the God of existence, is also known as "Narayan", which means one who resides in water. Saints

appearing in epics always lived in the vicinity of rivers, as physical purity associated with mental purity was believed a must in realizing eternal truth.

In all religious practices, the sprinkling of divine water is an inevitable part. The water is purified with "mantras", inviting the presence of the seven sacred rivers. This divine water is used to anoint the idol, which is then distributed to devotees. Associated with every Hindu temple and ashrams, there are big ponds and wells. It was a popular belief that bathing in holy rivers or drinking some drops of water from these rivers before the last breath, can help remove the sins acquired from the evil deeds during the lifetime and through the generations. In the functions following funerals and during the offerings to ancestors, bathing and dipping items for worship in holy water bodies, including the ocean, is considered of great spiritual value. Praying with a handful of water in the morning and the evening was part of daily life. There is several water bodies considered sacred in the different States of India. Cultural traditions have helped conserve many of the water resources and the forests and wetlands that maintain them. Former generations gave due consideration to the right to use water for all creations. Open wells have been in use for centuries. Near the well, they used to construct small pits to fill water so that birds, reptiles or animals could drink.

Water in traditional practices

Societies and cultures have traditionally developed sustainable techniques for conserving and managing nature and natural resources. Unfortunately, because of changing life styles, the rising cost of labour and the shortage of land availability due to the increasing population, this sustainable and environment-friendly method are becoming uncommon. However, the recent water crisis is initiating a drive to improve traditional, reliable and cost-effective domestic rainwater harvesting methods.

India has a fascinating and significant ancient tradition of conserving land and water and even today, local people follow several such traditional conservation practices. They include protecting patches of forests and water bodies in the name of local deities. This ecosystem consists of many species of trees, shrubs and rare herbs of high medicinal value. A well-protected pond helps a lot in recharging and conserving water is an essential part of the forest. The quality and quantity of water in nearby wells are largely influenced by this ecosystem. The old farmers could even predict droughts and floods by the observation of the pre-monsoon weather. To them the position of celestial bodies, clouds, winds and the behaviour of birds and animals were indicators of the nature of forthcoming rainfall and the availability of resources.

Conclusion

Water conservation in India is not a new concept. The Indus Valley civilization, one of the earliest civilizations, was the world's largest in extent. Agriculture was practiced on a wide scale, with extensive networks of canals for irrigation. There is several water bodies considered sacred in the different States of India. Cultural traditions have helped conserve many of the water resources and the forests and wetlands that maintain them. Almost every region in India has its own unique method of storing and conserving water prevalent since times immemorial. Water has always been a crucial element which plays an important role in both giving birth or terminates to any living being on the earth. The fact is we the humans, social animals must act responsibly for the conservation and proper use of water.

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WATER AS AN ECONOMIC GOOD

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Abstract

Natural resources are always an asset to the environment. But over the decades, most of the natural resources like water are becoming increasingly scarce, which indeed is a threat to the environment. Therefore all economies have to undergo a transition that is moving towards a resource efficient economy. To ensure this it is vital to price an economic value for water. This situation has occurred because of pollution and over exploitation of natural resources which is considered as a negative environmental externality. Therefore this paper provides a non- technical introduction to the concept of environment externalities and emphasize on the significance to save water resources by quoting a price value for it.

Keywords: *Economic value of water, pollution, over exploitation of natural resources, Environment externalities.*

Introduction

Externalities arise when certain actions of producers or consumers have unintended external effects on other producers or consumers in a society. Externalities can be classified in to two types. They are positive and negative externalities. Positive externality arises when an action by an individual or a group confers benefits to others. Negative externalities arise when an action by an individual or a group produces harmful effects on others. In an activity generating positive externality, social benefit is higher than private benefit and in an activity generating negative externality; social cost is higher than private cost. Thus, in the presence of externalities, social benefits and private benefits differ.

The divergence between private benefits and social benefits results in inefficiency in resource allocation. Producers of externalities do not have any incentive to take in to account the effects of their actions on others. In a competitive market economy, private optimum output is determined at the point where marginal private cost equals price. When a positive externality occurs, the marginal social benefit will be higher than the marginal private benefit and hence the private optimal output will be lower than the social optimal output. When a negative externality occurs the marginal social cost will be higher than marginal private cost and hence the private optimal level of output will be higher than the social optimal level of output. Government intervention is needed to internalize externalities in production and consumption decisions of individuals so that social optimal levels of outputs and private optimal levels of outputs will be the same. With this introduction of environmental externalities let us move forward to the objectives of paper.

Objectives

- To study the concept of environmental externalities.
- To study the significance of water pricing.
- To suggest measures for the vital usage of water.

Methodology

- The study is purely based on secondary data.
- Information related to environment externalities, water pricing was collected from national and international journals.

Review of literature

This literature review basically aims to provide a detailed account of literatures on the concept of environmental externalities and water pricing policy. It has also discussed those factors that resist the policy makers in quoting an economic value of water. Finally it gives a pragmatic view that in order to protect the natural resources proper economic valuation is indeed a necessary element.

An article by **Birkhofer et al., (2008)** has stated that population growth and rapid industrialization, environmental resources such as ground water and water in lakes, rivers and clean air in many places have become scarce resources. Industrial discharge of untreated effluents into water bodies and emissions into air has deteriorated the quality of air and water respectively. Negative intertemporal externalities occur when exhaustible resources are depleted and when renewable resources are harvested at rates greater than regeneration rates.

Patricia (2009) stated that water is vital for life and plays an essential role for economic development of countries. To address water scarcity issues, better pricing has been recognized as an important tool. In this paper several empirical studies which highlight water pricing theories and related models have been reviewed. These theories explain different aspect of water pricing that can be used as a means to improve water use efficiency. Analysis of partial equilibrium can be viewed as effects of a policy on a specific sector like agriculture, but an analysis of general equilibrium often involves steady-state paths which is in fact a macro-level approach. A comparison of first best pricing with second best pricing models shows that the latter are possible when transaction costs are included. In the absence of storage capacities limits and direct costs of water, development decision studies find that the price of water held in storage must rise at the rate of interest and that the effect of discounting is to cause a cycle in the water price. Finally, recent evidence suggests that the short-run efficiency of marginal cost pricing can be extended to account for long-run fixed cost considerations.

Sahibzada (2012) indicates that from the viewpoint of promoting the efficient use of water resources, water charges should be set at marginal costs or the equilibrium price. These prices have to be low because it should have access to people who are belonging to lowers sections of the society.

Dandy et al. (2014) analyzed a constrained water pricing method and found that such a method, while being less efficient than the optimal water pricing derived in their model, is still able to increase benefits to society when compared to actual average cost pricing practices.

Demand management and water use efficiency

- A system to evolve benchmarks for water uses for different purposes, i.e., water footprints, and water auditing should be developed to promote and incentivize efficient use of water. The 'project' and the 'basin' water use efficiencies need to be improved through continuous water balance and water accounting studies. An institutional arrangement for promotion, regulation and evolving mechanisms for efficient use of water at basin/sub-basin level will be established for this purpose at the national level.
- The project appraisal and environment impact assessment for water uses, particularly for industrial projects, should, inter-alia, include the analysis of the water footprints for the use.
- Recycle and reuse of water, including return flows, should be the general norm.
- Project financing should be structured to incentivize efficient & economic use of water and facilitate early completion of ongoing projects.
- Water saving in irrigation use is of paramount importance. Methods like aligning cropping pattern with natural resource endowments, micro irrigation (drip, sprinkler, etc.), automated irrigation operation, evaporation-transpiration reduction, etc., should be encouraged and incentivized. Recycling of canal seepage water through conjunctive ground water use may also be considered.
- Use of very small local level irrigation through small bunds, field ponds, agricultural and engineering methods and practices for watershed development, etc. need to be encouraged. However, their externalities, both positive and negative, like reduction of sediments and reduction of water availability, downstream, may be kept in view.
- There should be concurrent mechanism involving users for monitoring if the water use pattern is causing problems like unacceptable depletion or building up of ground waters, salinity, alkalinity or similar quality problems, etc., with a view to planning appropriate interventions.

Water pricing

- Pricing of water should ensure its efficient use and reward conservation. Equitable access to water for all and its fair pricing, for drinking and other uses such as sanitation, agricultural and industrial, should be arrived at through independent statutory Water Regulatory Authority, set up by each State, after wide ranging consultation with all stakeholders.
- In order to meet equity, efficiency and economic principles, the water charges should preferably / as a rule be determined on volumetric basis. Such charges should be reviewed periodically.
- Recycle and reuse of water, after treatment to specified standards, should also be incentivized through a properly planned tariff system.

- The principle of differential pricing may be retained for the pre-emptive uses of water for drinking and sanitation; and high priority allocation for ensuring food security and supporting livelihood for the poor. Available water, after meeting the above needs, should increasingly be subjected to allocation and pricing on economic principles so that water is not wasted in unnecessary uses and could be utilized more gainfully.
- Water Users Associations (WUAs) should be given statutory powers to collect and retain a portion of water charges, manage the volumetric quantum of water allotted to them and maintain the distribution system in their jurisdiction. WUAsshould be given the freedom to fix rates subject to floor rates determined by WRAs.
- The over-drawal of groundwater should be minimized by regulating the use of electricity for its extraction. Separate electric feeders for pumping ground water for agricultural use should be considered.

National water policy in India

National Water Policy is formulated by the Ministry of Water Resources of the Government of India to govern the planning and development of water resources and their optimum utilization. The first National Water Policy was adopted in September, 1987. It was reviewed and updated in 2002 and later in 2012.

India accounts for 18% of the world population and about 4% of the world's water resources. One of the solutions to solve the country's water woes is to link the rivers. India has been successful in creating live water storage capacity of about 253 billion cubic meter(BCM) so far. In a first, the ecological needs of river have also been taken into consideration. The major provisions under the policy are:

- Establishing a standardized national information system with a network of data banks and data bases.
- Resource planning and recycling for providing maximum availability.
- To give importance to the impact of projects on human settlements and environment.
- Guidelines for the safety of storage dams and other water-related structures.
- Regulate exploitation of groundwater.
- Setting water allocation priorities in the following order: Drinking water, Irrigation, Hydropower, Navigation, Industrial and other uses.
- The water rates for surface water and ground water should be rationalized with due regard to the interests of small and marginal farmers.

The policy also deals with participation of farmers and voluntary agencies, water quality, water zoning, conservation of water, flood and drought management, erosion etc.

National water policy 2012

The main emphasis of National Water Policy 2012 is to treat water as economic good which the ministry claims to promote its conservation and efficient use. This provision intended for the privatization of water-delivery services is being criticized from various quarters. The policy also does away with the priorities for water allocation mentioned in 1987 and 2002 versions of the policy. The policy was adopted with disapproval from many states. The other major features are:-

- To ensure access to a minimum quantity of potable water for essential health and hygiene to all citizens, available within easy reach of the household.
- To curtail subsidy to agricultural electricity users.
- Setting up of Water Regulatory Authority.
- To keep aside a portion of the river flow to meet the ecological needs and to ensure that the low and high flow releases correspond in time closely to the natural flow regime.
- To give statutory powers to Water Users Associations to maintain the distribution system.
- Project benefited families to bear part of the cost of resettlement & rehabilitation of project affected families.
- To remove the large disparity between stipulations for water supply in urban areas and in rural areas.
- To support a National Water Framework Law.

Critics of national water policy 2012

- Paradigm shift in approach from service provider of water to facilitator of service.
- Policy does not deter use among those who can afford to pay for water.
- Purchasing Power Parity mode may not ensure equity.

- Policy does not follow polluter pay principle; rather it gives incentives for effluent treatment.
- Policy was criticized for terming Water as an economic good.
- In some regions it has not yet become successful.
- The policy does not focus on the reduction of water pollution.

Suggestions for the vital usage of water resources

- Water has become a scarce natural resource and it is fundamental to life, livelihood, food security and sustainable development. Water is required for domestic, agricultural, hydro-power, thermal power, navigation, recreation, etc. Utilization in all these diverse uses of water should be optimized and an awareness of water as a scarce resource should be fostered.
- The Centre, the States and the local bodies (governance institutions) must ensure access to a minimum quantity of potable water for essential health and hygiene to all its citizens, available within easy reach of the household.
- Ecological needs of the river should be determined, through scientific study, recognizing that the natural river flows are characterized by low or no flows, small floods (freshets), large floods, etc., and should accommodate developmental needs. A portion of river flows should be kept aside to meet ecological needs ensuring that the low and high flow releases are proportional to the natural flow regime, including base flow contribution in the low flow season through regulated ground water use.
- Rivers and other water bodies should be considered for development for navigation as far as possible and all multipurpose projects over water bodies should keep navigation in mind right from the planning stage.
- In the water rich eastern and north eastern regions of India, the water use infrastructure is weak and needs to be strengthened in the interest of food security.
- Community should be sensitized and encouraged to adapt first to utilization of water as per local availability of waters, before providing water through long distance transfer. Community based water management should be institutionalized and strengthened.

Thus we can conclude by saying that save the nature for your future by proper utilization of resources.

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AN ANALYSIS OF DRINKING WATER IN URBAN AREAS WITH SPECIAL REFERENCE TO COIMBATORE CITY MUNICIPAL CORPORATION

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Abstract

Due to rapid development, increasing population and iniquitous distribution of water, the demand for this natural resource far outweighs its supply. In addition and for a while now, the water sector in India has faced significant and problematic issues related to management. India continues to struggle to meet its water sector infrastructure requirements, including operation and maintenance costs. There is critical situation in the water supply in urban areas and the demand and supply of water mismatches in the country. Relevant and required data for the present study were collected from primary sources with the help of interview schedule. The secondary data were also collected from the books, journals and websites. Multi Stage sampling technique has been used to select the data. The period of the study was December 2017 to March 2018. This study enlightens the problems and health issues faced by the respondents.

Introduction

Water is vital for life. Life and water on this planet are inseparable. It is an eternal wonder, a life given force a powerful agent of progress or ruin. Man must make use of the basic resources wisely for the progress and prosperity of mankind. Water is the precious commodity to the human life; if it is properly managed it can serve the society in number of ways. Depending upon the circumstances it can be both priceless and worthless, blessing and a curse. About 1460 Tera tones (Tt) of water covers 71 per cent of earth's surface, mostly in oceans and other large water bodies. Due to growth of urbanization, there is a problem in the urban water supply. There is always the mismatch between the demand and supply of the water.

In India, **Rout and et.al** (2016) stated that water in its natural form contains various components and its quality keeps on changing from time to time and place to place. The obtained results clearly revealed that the quality of Barara block was relatively safe for domestic purposes as most of the tested parameters were found within the Bureau of Indian Standards (BIS). **Yuvaraj and et.al** (2010) analyzed the drinking water supply in Coimbatore City Corporation at micro level. The main aim of the study was to found out the characteristics of distribution of water supply in Coimbatore city. They highlighted that there was an imbalance in the distribution of different drinking water supply means. **McKenzie and et.al** (2007) evaluvated that large numbers of households in cities around the developing world do not have access to a safe and reliable supply of drinking water. **Ghosh** (1993) analyzed the most common problem faced by urban population in a majority of the developing countries was the limited access to almost all the basic services like health, shelter and particularly water supply and sanitation facilities. There are many studies conducted by the various authors in the topic of urban water supply management in the both the developed and developing countries. But there are only limited studies in the drinking water analysis in urban cities. Hence the study on **An Analysis of Drinking Water in Urban Areas with Special Reference to Coimbatore City Municipal Corporation** was formulated with following **objectives.**

- To study the socio economic status of the selected sample respondents.
- To analyze the source of water supply in the selected areas.
- To assess the water problems and health issues faced by the selected sample respondents.
- To examine the water tariffs of the selected sample respondents.

Hypothesis

The following are the hypothesis framed for the study:

- To find out the relationship between the quality of water and the health issues faced by the selected respondents
- The Source of water varies significantly with the socio economic profile of the selected respondents such as age, sex, occupation, income and type of family.

Methodology

The study area was Coimbatore district in Tamilnadu. The total 50 sample respondents had been selected from five different areas of Coimbatore Corporations zones. They are 10 samples from the Poomarket, 10 samples from T.V.S Nagar, 10 samples from Thudiyalur, 10 samples from Vadamadurai and 10 samples from Cheran Nagar. The study was carried out in the period of December 2017 to March 2018. Relevant and required data for the present study were collected from primary sources with the help of interview schedule. The secondary data were also collected from the books, journals and websites. Multi Stage sampling technique has been used to select the data. To analyze the data Correlation, Simple Regression Analysis and Multiple Regression analysis, Percentage and diagrams were used to interpret the data.

Findings of the study

A. Socio economic status of the respondents

- 50 per cent of the respondents are between the age group of 21-40. In Poomarket 14 per cent of the populations are between 41-60. In Thudiyalur 14 per cent are between 21-40.
- 56 per cent of the respondents are Male and 46 per cent are Female. In Vadamadurai 18 per cent of the respondents are female and 2 per cent are male.
- 38 per cent of the respondents were studied up to high school level of education and 2 per cent are illiterate. In poomarket14 per cent of the respondents were studied up to high school.
- 42 per cent of the respondents are working in the private sector and 6 per cent of them are working in the Government sector.
- 48 per cent of the respondents are having the annual income of Rs. 50,001 to 1, 00,000 and about 4 per cent of them are having the income of Rs. 5, 00,001 to 10, 00,000.
- 100 per cent of the respondents belong to the Nuclear family. None of the respondents belongs to the Joint family.

B. Housing structure of the respondents

- 50 per cent of the respondents have their own house and 50 per cent of them have rental house. In Poomarket 14 per cent of the respondents are in rental houses.
- Among the 25 respondents (who are paying the Rent), 64 per cent of the respondents pay their rent about Rs. 3001 to 6000 and 4 per cent pay about 6001 to 9000.
- 80 per cent of the respondents have Independent house and 20 per cent have apartment house. In Poomarket 16 per cent of the respondents have Independent house and 4 per cent have apartment house.

C. Source of water

- 86 per cent of the respondents have the pipe connection inside their house for drinking water and 14 per cent of them have their drinking water from the public taps.

D. Respondents using pipe connection inside their house for drinking water

- 69.75 per cent of the respondents said that the water will come once in a week and 2.32 per cent of the respondents said that water will come for 15 days once.
- 60.47 per cent of the respondents said that water will be supplied in the morning and 2.32 per cent said that water will come in the night time.
- 86.05 per cent of the respondents said that water will come about 0-3 hours and 13.95 per cent said that water will come for 4-6 hours.
- 69.76 per cent of the respondents said that the supply of water is adequate and 30.24 per cent said that water is inadequate.
- 62.79 per cent of the respondents said that the pressure of the water is adequate and 25.58 per cent of the respondents said that the pressure is inadequate.
- 23.25 per cent of the respondents said that they will store the water in the Cement tank, vessels and pots and 2.32 per cent of them said that they will store the water in the cement tank, synytex, vessels and pots.

E. Respondents using public taps for drinking water

- 14 per cent of the respondents are using the public taps for the consumption of the drinking water.
- Among the 7 respondents (who are depending upon the public taps),42.85 per cent of them where from Cheran Nagar and 28.57 per cent of the respondents belongs to Thudiyalur and Vadamadurai.

- 57.13 per cent of the respondents said that the distance from their home and the public tap is 10 meter.
- 100 per cent of the respondents felt that there is no difficulty due to the distances.
- 71.42 per cent of the respondents said that the water will be supplied once in a week.
- 71.42 per cent of the respondents said that the water will be supplied in the morning time.
- 85.71 per cent of the respondents said that the water will come for about 0-3 hours.
- 85.71 per cent of the respondents said that the water supplied adequate for their consumption.
- 57.14 per cent of the respondents said that the pressure of the water is adequate.
- 28.57 per cent of the respondents said that the water will be stored in the cement tank, syntex and pots.

F. Water problems of the respondents

- 54 per cent of the respondents said that the quality of water is bad and 42 per cent of them said that water quality is good.
- 46 per cent of the respondents said that they don't have any problem with the water and 20 per cent of the respondents said that there is more chlorine smell in the water.

G. Health issues faced by the respondents

- 62 per cent of the respondents said that they don't have any health issues and 14 per cent of the respondents said that they mostly suffer from cold and 2 per cent of them suffer from dysentery and cold.

H. Other problems of the respondents

- 68 per cent of the respondents said that there will be no breaking of pipelines and 32 per cent of them said that there is frequent breaking of the pipelines.
- 56.25 per cent of the respondents said that when there is breaking of the pipelines they will inform to the corporation office and 18.75 per cent of the respondents said that if there is frequent breaking of the pipelines, they will move onto new connections.
- 10 per cent of the respondents said that water is inadequate and 2 per cent of them said that there are insects in the water, proper information is not there.

I. Respondents having connections

- 62 per cent of the respondents have one connection and 12 per cent have two and three connection.
- 83.71 per cent of the respondents are having the metered connections and 16.29 per cent of them do not have metered connections.

J. Water tariffs paid by the respondents

- 84 per cent of the respondents make the payment of Rs 0-500 and 1 per cent of them pay Rs. 1001-1500.
- 44.18 per cent of the respondents pay the water tariffs one month once and 2.32 per cent of them pay the amount in 12 months once.
- 100 per cent of the respondents pay their water tariffs through cash mode.
- 88.37 per cent of the respondents pay on the basis of meter rate and 11.63 per cent of them pay on the basis of flat rate.
- 93.02 per cent of the respondents said that they do not have any problems and 6.98 per cent of them felt that the office is far away from their house.

Correlation analysis

The relationship between quality of water and the health issues faced by the respondents is examined with the help of correlation. There is a **negative relationship between the quality of the water and the health issues face by the respondents.**

Simple regression analysis

The Simple Regression has been analyzed for the quality of water and the problems associated it with. The table shows that the two variables are **negatively related** and it is statistically significant at 5 per cent and 1 per cent level. The value of R^2 is .601. It shows that 60 per cent of the variations in independent variable is explained by the explanatory variables and the remaining 40 per cent of the variations is explained by random factors. The value of F is 72.327. The probability value is 0.00. It indicates that it is statistically significant at both 5 per cent and 1 per cent.

Multiple regression analysis

The dependent variable is source of water and the independent variables are occupation, annual income, ownership of the house, water tariffs and frequent breaking of pipelines. This table show that the **source of water is**

dependent on the ownership of the house and **independent on the occupation, annual income, amount spent for water and frequent breaking of pipelines.** The value of R^2 is .683. It shows that 68 per cent of the variations in independent variable is explained by the explanatory variables and the remaining 32 per cent of the variations is explained by random factors.

Conclusion

Water is essential for survival and is required in adequate quantity to remain healthy. The rapid growth of population and its glowing needs has meant that percapita availability of fresh water has declined sharply from 3000 m^3 to 1123 m^3 over the past 50 years. India is designated as a "Water Stressed Region" with useable freshwater standing at 1122 cubic meter per year and per capita compared to international limiting standards of 1700 cubic meter. Increasing urbanization, growing water demands, pollution of nearby water sources and depletion of sources due to over exploitation have all contributed to the current crisis of potable water. It is thus time to take stock of the situation and initiate remedial measures to avoid the impending crisis because the demand for water will increase in the future due to increasing populations and rapid growth of urbanization. To overcome the problem people must properly utilize the water and there must be proper water management.

Suggestions

To overcome the problems some suggestions are given. They are

- Rainwater Harvesting
- Water reuse or water from waste water must be reused.
- Conservation of supplied water.
- Ground water recharge

Limitations of the study

The limitations of the study are as follows

- The study is based on the micro level analysis not applicable in macro level.
- The findings depend on the information given by the respondents.
- Time and financial constraint are main limitations.
- The findings and conclusion could be applicable only to the similar set of peoples.

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WATER AND ENVIRONMENT

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Abstract

Environment is everything that is around us. The components of the environment include Atmosphere, Lithosphere, Hydrosphere and Biosphere corresponding to Air, Rocks, Water and Life respectively. These are individual entities which are closely related and highly interdependent. Of these, Water holds an unique place because it not only constitute 70% of the earth but also plays a vital part in the life of all living things. Yet its relationship with other entities is hardly understood nowadays. A better understanding of a problem helps in proposing better solutions. This paper focus on facilitating a better understanding about the indispensability of water by correlating the soil type, water quality, rainfall, temperature, population and urbanization data of Tamil Nadu during the past years. This in future helps us to formulate and propose better solutions for various environmental problems.

Introduction

Humans are the ultimate beneficiaries of the Environment. Yet there are many people who couldn't get their basic needs such as food, water and shelter globally. Rapid population growth stands as a barrier for humans to attain their basic needs. In the present population of 7.6 billion, it is found that 815 million people suffer from hunger and 844 million people lack access to clean water. In order to get their basic needs, people started migrating which resulted in 71.44 million refugees during 2017 worldwide. Of these basic needs, water is the most important since it make up 60% of human body. Hence should start to concern more about the environment from which they seek water.

Background

Earth originated 4.6 billion years ago and ever since it is dynamic. Formerly life originated in the form of unicellular organisms which then during course of time evolved into multi cellular with prominent physical, chemical and biological changes. Along with these evolutionary changes the environment also changed simultaneously. It includes both constructive and destructive changes.

Environment mainly consists of four spheres namely Atmosphere, Lithosphere, Hydrosphere and Biosphere. It is evident that these spheres are related to one another in a cyclic manner such that the changes in them are in a sequential manner.

In the present scenario environmental changes has become a major threat for human survival. The environmental changes lead to global warming, drastic climatic, temperature, monsoonal changes, flood, drought etc which impart a significant change in the day to day life of all living things.

Of these the issues related with water attracts more attention since it has a totally different genera of problems. As we all know that, earth consists of 70% water and 30% land. Of these, just 3% of water is freshwater in which 2% is contained in glaciers, ice sheets and as groundwater. The remaining 1% is found in lakes, rivers, wetland areas or transported through the atmosphere in the form of water vapour, clouds and precipitation.

Objectives

The main objective of this paper is

- To facilitate a better understanding about the place that water holds in the environment.
- To figure out how the major environmental problems are related to one another.
- To understand the environmental cycle.

Study area

The environmental changes is prominently observed worldwide. In this paper Tamil Nadu is taken as the area of interest and its temperature, rainfall, soil type, Groundwater, population data are correlated.

Tamil Nadu is the southern-most state of India. It is located in the Indian peninsula between the Bay of Bengal in the east, the Indian Ocean in the south and the Western Ghats and the Arabian sea on the west. It is situated between the latitude 8º5'N and 13º35'N and between longitude 76º15'E and 80º20'E.Its the 11th largest state in India with an area of 1,30,058 sq km. The bordering states are Kerala to the west , Karnataka to the north west and Andhra Pradesh to the north. To the east is the Bay of Bengal and the state encircles the union territory of

Puducherry. The southernmost tip of the Indian Peninsula is Kanyakumari which is the meeting point of the Arabian Sea , the Bay of Bengal and the Indian Ocean. Tamil Nadu has a coastline of about 1,076 km which is the country's second largest coastline. Tamil Nadu falls mostly in a region of low seismic hazard with the exception of the western border areas that lie in a low to moderate hazard zone.

Methodology

The most important need of the hour is to track the trend of growth , predict the future and to take some preventive measures corresponding to the Environmental problems. Since the past holds the key to the future, the past data of various entities were taken into consideration for analysis and correlation. So the past data corresponding to rainfall, temperature, soil type, ground water and population of Tamil Nadu were collected and the correlation between each entity was found. Finally the hidden reasons which are the source for, all the problems in the present was identified.

Rainfall (Atmosphere)

It is the amount of precipitation falling over a given area in a period of time.

The trend in monthly mean rainfall of Tamil Nadu during 1951-2010 is as follow

1951-2010	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
mm/y	0.00	0.00	+0.03	-0.26	-0.36	-0.27	-0.65	-0.48	-0.10	-0.18	+1.54	+0.13

The annual and seasonal rainfall trend of Tamil Nadu during 1951-2010 is as follow

1951-2010	Annual	Winter	Summer	Monsoon	Post Monsoon
mm/yr	+0.80	-0.16	-0.47	-1.35	+1.49

From the above data it is evident that the annual rainfall of Tamil Nadu is increased by 0.80mm/yr. Yet, the state experiences extreme dry condition during summer because the increased trend in rainfall is confined to monsoon season only.

Temperature (Atmosphere)

It is the degree of hotness or coldness of the atmosphere on some chosen scale. It is commonly measured in Celsius or Farenheit.

The trend in mean monthly temperature of Tamil Nadu during 1951-2010 is as follow

1951-2010	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean °c/yr	+0.03	+0.03	+0.03	+0.03	+0.02	+0.02	+0.03	+0.02	+0.02	+0.02	+0.02	+0.03

Annual and seasonal mean temperature of Tamil Nadu during 1951-2010 is as follow

1951-2010	Annual	Winter	Summer	Monsoon	Post Monsoon
°c/yr	+0.02	+0.03	+0.03	+0.02	+0.02

The above data show that the annual temperature is increased by 0.02°c/yr .The overall temperature is increased 1.18°c during those 59 years. The temperature change is considered as one of the reasons for decrease in soil moisture and drought.

Soil Type (Lithosphere)

Soil is an unconsolidated aggregate of mineral and rock fragments ranging in size from clay, silt, sand and gravel. Infiltration is the movement of water into the soil surface. Runoff is the water that is pulled by gravity across land's surface, replenishing ground water and surface water as it percolates into an aquifer or moves into a river, stream or watershed. Moist soils produce more runoff than dry soils. Sandy soils allow water to infiltrate while silt and clay have slow infiltration rate. Loam have better infiltration than sand and clay.

The soil types found in various districts of Tamil Nadu is as follow

Districts	Soil type
Kancheepuram, Tiruvallur, Cuddalore, Vellore, Tiruvannamalai	Red sandy loam, clay loam, saline coastal alluvium.
Dharmapuri, Salem, Namakkal	Non calcareoused, non calcareous brown, calcareous black.
Erode, Coimbatore, Tiruppur, Karur, Dindigul, Theni	Red loam, Black.
Trichy, Perambalur, pudukkottai, Thanjavur, Nagapattinam, Tiruvarur, Port of Cuddalore	Red loam, Alluvium.
Madurai, Sivagangai, Ramanathapuram,Virudhunagar, Tirunelveli, Thoothukudi	Coastal alluvium, black red sandy soil, deep red soil.
Kanyakumari	Saline coastal alluvium, deep red loam
The Nilgiris and Kodaikanal	Eritic

From the above data it is obvious that Red soils are found in almost every district of the state. It occupy major parts of Madurai, vellore and 63% of Tiruvallur, Kancheepuram, Salem, Coimbatore, Tirunelveli, Trichy.

Groundwater (Hydrosphere)

It is considered as a very important natural resource. In arid, semi arid and dry regions this may be the only source of water supply. Even in humid areas, groundwater is considered a better resource for many economic and hygienic reasons. Groundwater includes all the subsurface water reaching a depth below which all the pore spaces, openings and other cavities of the soil and rock are completely filled with water. Surface water and ground water are interrelated since surface water seeps through the soil and becomes Groundwater. Groundwater is expressed in both quantitative and qualitative aspects.

Quantity

Every district in Tamil Nadu has been classified based on amount of Ground Water Abstraction.It is classified into different blocks based on the level of Ground water.

The Groundwater Potential of Tamil Nadu during 2014-2015 is as follow

Categorisation of Blocks	No. of Blocks
Over Exploited(>100%)	142
Critical(90-100%)	33
Semi critical (70-90%)	57
Safe(<70%)	145
Saline Blocks	8
Total	**385**

Quality

The quality of Groundwater is mainly affected by the contaminants such as Fluoride, Nitrate, Iron, Coliform etc which comes from point and non point sources.

The top 5 districts with high % of contaminants in Tamil Nadu during 2014 is as follow

Districts	% of all contaminants
Dharmapuri	88.13
Theni	57.55
Ramanathapuram	50.08
Tirupur	40.51
Dindugal	40.14

Population (Biosphere)

As per Census 2011, the total population of Tamil Nadu is 74.14 million. Of this, the rural population is 37.2 million and the urban population is 34.9 million. The percentage decadal growth for total population during 2001-2011 is 15.6.In this the Urban growth is 27% and the Rural growth is 6.6%.Tamil Nadu accounts for 9.6% of Urban population in country level while only comprising 6% of India's total population according to 2011 census.

Industrial Growth (Biosphere)

The industrial growth in Tamil Nadu during 2013-2014 is 5.14% with 2004-2005 as Base year.

Results

The collected data about Tamil Nadu corresponding to various entities gives us a clear picture about the changes which the environment had undergone. The important conclusions is as follow

- Even though the annual rainfall had increased ,its major confinement to post monsoon made it less useful. The reduction in rainfall during monsoon by 1.35mm/yr made a notable impact on temperature.
- The reduction in rainfall during the dry seasons reduced the soil moisture and humidity leading to annual increase in temperature by 0.02ºc/yr.
- The increase in temperature is unfavorable for agriculture which sometimes lead to drought and famine in some regions. High amount of rainfall in a confined period also cause soil erosion particularly in places where there is no trees to hold the soil. This ultimately lead to the exposure of hard rocks which does not favor the infiltration of water.
- Reduction in rainfall and infiltration lead to reduction in Groundwater level. In addition to that, Over exploitation in some places , increased the depth of ground water. The contamination of Groundwater worsen the situation by causing water related diseases.
- Due course, the population increased gradually.
- Reduction in rainfall, increase in temperature, unavailability of water entirely unfavoured agriculture and made the survival of ordinary people difficult.
- In order to survive, people started migrating to cities where they found opportunities to earn for their living by various available means. This resulted in urbanization. The decadal urban growth during 2001-2011 is 27%.

- In order to provide employment industrialization started in the cities and attained 5.14% growth rate during 2013-2014.
- To construct industries and to find shelter deforestation took place which ultimately lead to reduced forest cover.
- Deforestation results in decline of water vapor in the atmosphere as a result of which condensation and precipitation process are affected which finally results in reduction of rainfall. Therefore this cycle begins again .
- Hence it is extremely important to maintain balance between the spheres since the human beings are the ultimate beneficiaries of the environment. Yet they cause imbalance in the cyclic process unknowing that they are the receivers of the consequences.

Conclusion

Thus by using the data corresponding to various entities of Tamil Nadu, their sequential relationship was understood. This will help us to propose highly effective solutions in future for various environmental problems.

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WATER POLLUTION IN INDIA – A THREAT TO MANKIND

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Abstract

Water pollution is emerged as one of the most serious environmental threats in India. It is the contamination of water bodies such as rivers, ponds, lakes, oceans and ground water. According to WHO, 80% of surface water in India is polluted. It occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove harmful components. This study is an attempt to identify the causes and effects of water pollution on mankind in India. This paper concludes with some suggestions to overcome the problem. This study is purely based on secondary data.

Keywords: *Water Pollution, Contamination, WHO, Pollutants.*

Introduction

"Water is life's matter and matrix, mother and medium. There is no life without water"
-Albert Szent Gyorgyi

Water is a precious gift of nature to mankind and millions of other species living on the earth. 20th century is characterised by intensive development of industry, transport, energy, the industrialization of agriculture and so on. All this has resulted in water pollution. Water pollution is emerged as one of the most serious environmental threats in India. Water pollution is the contamination of water bodies such as lakes, rivers, oceans and groundwater, without any treatment to remove harmful compounds. Over the last three decades there has been increasing global concern over the public health impacts attributed to environmental pollution. As mentioned in "Agenda 21" of the UN conference on environment and development (UNCED), "an estimated 80 per cent of all diseases and one-third of deaths in developing countries are caused by the consumption of contaminated water, and on an average, much as one tenth of each person's productive time is sacrificed to water related diseases.

Review of litreature

Bindhy Wasini Pandey and et.al(2017), made an attempt to analyse the water pollution and its impact on human health in Allahabad City. **Mehtab Haseena and et.al(2017),** analysed the water pollution and its impact on human health. They also recommended to examine the water quality on regular basis to avoid its destructive effects on human health. **Mashhood Ahmad Khan and Arsalan Mujahid Ghouri(2011),** examined that pollutions are not only seriously affecting the human by diseases and problems but also the animals and trees/ plants.

Objectives of the study

The main objectives of the study are as follows:

- To identify the causes of water pollution in India.
- To know the effects of water pollution on humanbeing in India.

Methodology

This study is purely based on Secondary sources like Journals, Magazines, Reports and Websites.

Findings of the study

Causes of water pollution

The causes for water pollution are as follows:

- **Sewage and waste water:** Sewage and garbage and liquid waste of households, agricultural lands and industries are discharging into rivers and lakes. They contain harmful chemicals and toxins which makes the water poisonous and leads to water borne diseases. An estimated 62,000 million litres per day sewage is generated in urban areas, while the treatment capacity across India is only 23,277 million litres per day, or 37% of sewage generated, according to the data released by Government of India on December 2015.
- **Dumping:** Dumping of solid wastes in water bodies may affect the humanbeings, aquatic plants and animals. According to Indian Union Ministry of Environment, Forest and Climate change in 2016, the total solid waste generated is 62 million tons per year in India.

Table 1 Represents the sources of solid waste in waterbodies

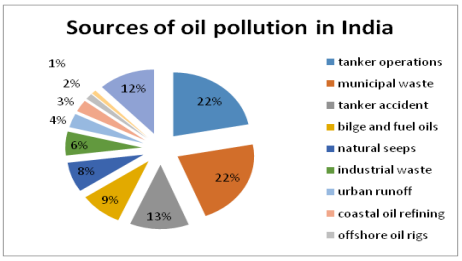
S.No	Source	Waste (in Million Tons)
1.	Plastic waste	5.6
2.	Bio-medical waste	0.17
3.	Hazardous waste	7.90
4.	E-waste	15

Source: Union Ministry of Environment, Forest and Climate change(2016)

From the above table it is understand that, plastice waste in water bodies is 5.6 million tons, bio medical waste is 0.17 million tons, hazardous waste is 7.90 million tons and e-waste is 15 million tons.

- **Industrial waste:** Industrial waste contains pollutants like asbestos, lead, mercury and petrochemicals which are extremely harmful to people and environment. According to Union Ministry of Environment, Forest and Climate change 2016, in India 43,936 industries generate over 70 lakh tons of waste annually.
- **Eutrophication:** Eutrophication is an increased level of nutrients in water bodies. This resulted in bloom of algae in water. It also depletes the oxygen in water, which negatively affects fish and other aquatic animal population.
- **Oil pollution:** Oil pollution is most common in large water bodies like seas and oceans. Oil spills occur due to the release of a liquid petroleum hydrocarbon into the marine water is especially affected by this form of pollution. Oil pollution is primarily a man-made pollution and is a result of human irresponsible activities.

Figure 1 Sources of oil pollution in India



Source: Central Pollution Control Board, 2017

1) Effects of Water Pollution

The effects of water pollution on humanbeings are as follows:

- **Unsafe Drinking Water**
  It is due to water pollution, the drinking water becomes distasteful. Micro organisms present in the water gives unpalatable taste. According to Central Bureau of Health Intelligence & Ministry of Health in the year 2017, one in seven people doesn't have access to clean drinking water and also one person dies every 4 hours in India due to unsafe water.
- **Affecting industrial units**
  Water pollution may leads to reduce the ability of industries as it affects the performance of industrial units. If the performance of the industries reduces, it leads to the reduction in employment, income and standard of living of the people.
- **Water borne diseases**
  Polluted water leads to the worsen effect on human health. United Nations report says that more than three million people in the world die of water related diseases due to contaminated water each year, including 12 million children. In India, over one lakh people die of water-borne diseases annually.
  - **Cholera:** Cholera is an acute diarrhoeal disease that can kill within hours if left untreated. It strikes when one ingests water that is infested with the Vibro Cholerae Bacterium.
  - **Diarrhoea:** Diarrhoeal infection is spread through food and drinking water that has been contaminated. It can last upto 2 weeks and leave the person completely dehydrated.
  - **Malaria:** Malarial fever is spread by the plasmodium parasite mosquito that breeds in water bodies like lakes, ponds and stagnant water.
  - **Filariasis:** It is a parasitic disease and affects people who live near unsanitary water bodies or sewages. It is spread by mosquitoes that breeds in stagnant water bodies and is the host of the filarial nematode worm. This worm affects humans and leads to elephantitis.
  - **Typhoid:** Fluctuating high fever, exhausion, sleepiness, diarrhoea etc., are signs of typhoid. This infection spread through contaminated food and water through close contact with an infected person.

Table 2 Water borne diseases in India

Disease	2014		2015		2016		2017	
	Cases	Death	Cases	Death	Cases	Death	Cases	Death
Cholera	844	5	913	4	718	3	385	3
Diarrhoea	11748631	1137	12913606	1353	14166574	1555	9230572	840
Typhoid	1736687	425	1937413	452	2215805	511	1493050	286
Others	138554	400	140861	435	145970	451	98086	283

Source: Ministry of Health, 2018

From the above table it is understood that people in India is highly affected by waterborne diseases especially diarrhoea.

Suggestions to overcome the problems

The suggestions to overcome the water pollution problems are as follows:

- Reducing the use of plastics may lead to better environment.
- Recycling the waste water and reusing it.
- Do not dispose oils in sewage, it leads to oil pollution.
- Use environmental friendly detergents.
- Avoiding the use of pesticides and fertilisers which is harmful to the environment.
- Creating awarness about water pollution among the people.

Conclusion

In today's world, sewage water pollution is one of the major problems faced by most cities. This kind of pollution leads to health-related and environmental issues. With proper treatment of water, it is possible to reduce water pollution. Let's pledge to keep our environment clean and the harmful effects of water pollution at bay.

"Pollution is nothing but the resources, we are not harvesting. We allow them to disperse because we have been ignorant of their values"

-R. Buckminster Fuller

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METHODS OF RAIN WATER HARVESTING AND IT'S NEED FOR ENVIRONMENT

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Abstract

Over the years, the rising population, growing industries and expanding agricultural practices have raised the demand of water supply. Rainwater harvesting will not only be helpful to meet the demand of water supply but also be helpful to improve the quantity and quality of water. Often, as a frantic response to problem of water scarcity and consequent hardships faced by both urban and rural communities. India has invested heavily in rainwater harvesting. The Rainwater harvesting is the simple collection or storing of water through scientific techniques from the areas where the rain falls. It involves utilization of rain water for the domestic or the agricultural purpose. This study enlightens the methods and need of rainwater harvesting and the relevant and required data were collected from the secondary sources.

Introduction

One of the biggest challenges of the 21st century is to overcome the growing water shortage. Water shortages can be relieved if rainwater harvesting is practiced more widely. People collect and store rainwater in buckets, tanks, ponds and wells. Rainwater harvesting is a simple low-cost technique that requires minimum specific expertise or knowledge and offers many benefits. Rainwater harvesting is one of the alternative technology for delivering drinking water. Water is the most common or major substance on earth, covering more than 70% of the planet's surface. For improving per capita water availability in the country, replenishment of ground water resources is a necessity which can be done very effectively through rain water harvesting. Fresh water today is a scarce resource, and it is being felt the world over.

Review of literature

Tanu Singh and L.S. Kandari (2012) had explained the rainwater harvesting in the wake of climate change in simla city of himachal Pradesh. They observed that, the city is suitable for rainwater harvesting as it had the required potential for it and received a good amount of rainfall during rainy season (from June-September), which constituted almost 70% of the total rainfall in the region. **Rehan and Jain (2014)** had analysed the rooftop rain water storage of the building to cater the need of water requirement. **Dr. Vijaykumar M Devappa1 et al. (2017)** studied the rain water harvesting and quality of water in S.G.Balekundri institute of technology campus at Belagavi, Karnataka. They analyzed that the quantity of water depends on intensity of rainfall and the surface of the roof, and additional sources of water are always needed. For long periods of drought, it is necessary to store excessively large volumes of water.

Objectives

- To know the methods of Rainwater harvesting.
- To find out the needs of Rain water harvesting.
- To analyse the components of rain water harvesting.
- To examine the pro's and con's of rainwater harvesting.

Methodolody

This study is based on secondary data collection from various resources like books, journals, newspapers and websites.

Findings of the study

A. Methods of harvesting rainwater

There are three methods of harvesting rain water as given below :

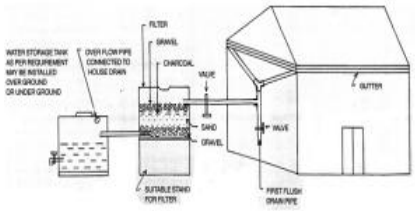
a. Storing rain water for direct use.
b. Recharging ground water aquifers, from roof top run off.
c. Recharging ground water aquifers with runoff from ground area.

a. Storing rain water for direct use

In place where the rains occur throughout the year, rain water can be stored in tanks. However, at places where rains are for 2 to 3 months, huge volume of storage tanks would have to be provided. In such places, it will be more appropriate to use rain water to recharge ground

water aquifers rather than to go for storage. If the strata is impermeable, then

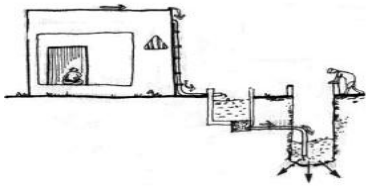
storing rain water in storage tanks for direct use is a better method.



Similarly, if the ground water is saline/unfit for human consumption or ground water table is very deep, this method of rain water harvesting is preferable.

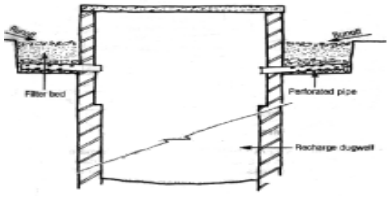
b. Recharging ground water aquifers from roof top run off

Rain water that is collected on the roof top of the building may be diverted by drain pipes to a filtration tank (for bore well, through settlement tank) from which it flows into the recharge well, as shown in . The recharge well should preferably be shallower than the water table. This method of rain water harvesting is preferable in the areas where the rainfall occurs only for a short period in a year and water table is at a shallow depth.



c. Recharging ground water aquifers with runoff from ground areas

The rain water that is collected from the open areas may be diverted by drain pipes to a recharge dug well / bore well through filter tanks as shown in. The abandoned bore well/dug well can be used cost effectively for this purpose.



B. Need for rainwater harvesting

- To overcome the inadequacy of surface water to meet our demands.
- To arrest decline in ground water levels.
- To improve ground water quality by dilution.
- To increase agriculture production.
- To improve ecology of the area by increase in vegetation cover etc.
- To enhance availability of ground water at specific place and time and utilize rain water for sustainable development.

The scarcity of water is a well known fact.Surface water sources fail to meet the rising demands of water supply in urban areas, groundwater reserves are being tapped and over-exploited resulting into decline in groundwater levels and deterioration of groundwater quality. In coastal areas like Chennai, over exploitation of ground water resulted in sea water intrusion thereby rendering ground water bodies saline. In rural areas also, government policies on subsidized power supply for agricultural pumps and piped water supply through bore wells are resulting into decline in ground water table. The solution to all these problems is to replenish ground water bodies with rain water by man made means.

C. Components of rainwater harvesting

The rain water harvesting system consists of following basic components

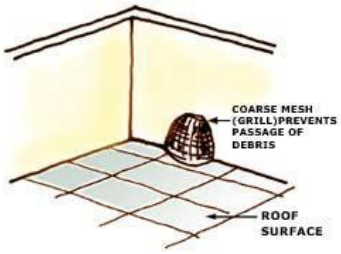
- Catchment area
- Coarse mesh / leaf screen
- Gutter
- Down spout or conduit
- First flushing device
- Filter
- Storage tank

1. Catchment area

The catchment of a water harvesting system is the surface which directly receives the rainfall and provides water to the system. It can be a paved area like a terrace or courtyard of a building, or an unpaved area like a lawn or open ground. A roof made of reinforced cement concrete (RCC), galvanised iron or corrugated sheets can also be used for water harvesting.

2. Coarse mesh

To prevent the entry of leaves and other debris in the system, the coarse mesh should be provided at the mouth of inflow pipe for flat roofs.



3. Gutters

Channels all around the edge of a sloping roof to collect and transport rainwater to the storage tank. Gutters can be semi-circular or rectangular and could be made using:

- Locally available material such as plain galvanised iron sheet (20 to 22 gauge), folded to required shapes.
- Semi-circular gutters of PVC material can be readily prepared by cutting those pipes into two equal semi-circular channels.
- Bamboo or betel trunks cut vertically in half.

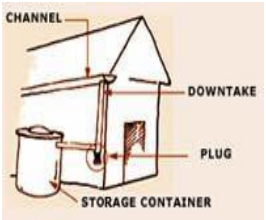
The size of the gutter should be according to the flow during the highest intensity rain. It is advisable to make them 10 to 15 per cent oversize. Gutters need to be supported so they do not sag or fall off when loaded with water. The way in which gutters are fixed depends on the construction of the house; it is possible to fix iron or timber brackets into the walls, but for houses having wider eaves, some method of attachment to the rafters is necessary.

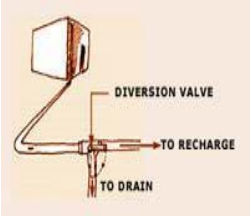
4. Conduits

Conduits are pipelines or drains that carry rainwater from the catchment or rooftop area to the harvesting system. Conduits can be of any material like polyvinyl chloride (PVC) or galvanized iron (GI), materials that are commonly available.

5. First-Flushing

A first flush device is a valve that ensures that runoff from the first spell of rain is flushed out and does not enter the system. This needs to be done since the first spell of rain carries a relatively larger amount of pollutants from the air and catchment surface.





Harve

6. Filter

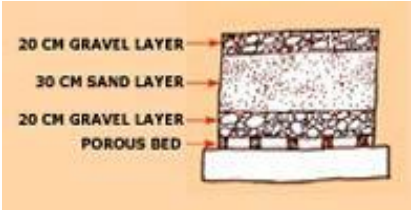
The filter is used to remove suspended pollutants from rainwater collected over roof. A filter unit is a chamber filled with filtering media such as fibre, coarse sand and gravel layers to remove debris and dirt from water before it enters the storage tank or recharge structure. Charcoal can be added for additional filtration.

1. Charcoal water filter

A simple charcoal filter can be made in a drum or an earthen pot. The filter is made of gravel, sand and charcoal, all of which are easily available.

2. Sand filters

Sand filters have commonly available sand as filter media. Sand filters are easy and inexpensive to construct. These filters can be employed for treatment of water to effectively remove turbidity (suspended particles like silt and clay), colour and microorganisms.



In a simple sand filter that can be constructed domestically, the top layer comprises coarse sand followed by a 5-10 mm layer of gravel followed by another 5-25 cm layer of gravel and boulders.

7. Storage tank

Whenever the rain water collected from roof top is used directly for various purposes, storage tank is required. The storage tank can be cylindrical, rectangular or square in shape. The material of construction can be RCC, ferrocement, masonry, PVC or metal sheets. Depending upon the availability of space, the storage tank can be above ground, partially underground or fully underground.

D. Advantages and disadvantages of Rainwater Harvesting

Advantages of rain water harvesting

The advantages of rainwater harvesting are as follows:

- Promotes adequacy of underground water.
- Mitigates the effect of drought.
- Reduces soil erosion as surface run-off is reduced.
- Storing water underground is environment friendly.
- Improves ground water table, thus saving energy

- Improves ground water quality / decreases salinity (by dilution) and it is not directly exposed to evaporation and pollution.
- Reduces the cost for pumping of ground water.
- Provides high quality water, soft and low in minerals.
- Rainwater harvesting systems are simple which can be adopted by individuals.
- Rooftop rain water harvesting systems are easy to construct, operate and maintain.

Disadvantages of rainwater harvesting

- Rain water harvesting is suitable for only those areas that receive plenty of rainfall. The unpredictable rainfall is also a drawback for adopting rainwater harvesting systems.
- Initially it incurs higher costs, even though it earns return only after a long period of installation.
- Rainwater harvesting system requires regular maintenance as they may get prone to rodents, mosquitoes, algae growth, insects and lizards.
- Certain types of roofs may seep chemicals, insect's dirt or animal droppings that can harm plants if it is used for watering plants.
- There is a limit for collection and storage of rainwater. Therefore during heavy downpour, the collection systems may not be able to hold all rainwater.

Conclusion

One of the most logical steps towards this goal would be acknowledging the importance of rainwater harvesting. Hence, an equal and positive thrust is needed in developing and encouraging both the types of water harvesting systems. We have to catch water in every possible way and every possible place it falls.

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WATERSHED MANAGEMENT FOR A BETTER FUTURE

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Abstract

Our world is made up of water in a large amount comparatively and this is a well known fact. In that a large quantity is of salinity where as a very few is fresh and useful for the mankind. Water is of the most important NATURAL RESOURCE as per today's condition. The world is being threaded by water scarcity in a very high ratio. The only way to sustain is conservation of water. It is in a great demad due to the rise in population. But still there are more ways to get sufficient amount of water for our need. One such ways is monitoring and maintaining the watersheds. Watershed is the geo-hydrological unit draining to a common point by a system of drains. Watershed management not only maintains the drainage and storage but also the land surface and vegetation so as to conserve soil and water. The watershed management has some objectives namely (1) production of food (2) pollution control (3) minimizing of over exploitation (4) water storage, flood control (5) wildlife preservation (6) erosion control (7) employment generation (8) groundwater recharge (9) alternate land use system. This could be done with a regular checkups and instant repairments. Various programmes would be implemented and should be maintained properly. The department of Land Resource, Ministry of Rural Development is implementing the Integrated Watershed Development Programme. The IWMP is the 2nd largest watershed management after China. The proper management of the watersheds is one of the best ways to recharge all sources of water and it will outcome the water scarcity.

Introduction

Water

It is one of the most important things for each and every living organism on the earth. Water is transparent, odorless and nearly colourless chemical substance that is the main constituent of earth's streams, lakes, oceans and fluids of the most living organisms and that is vital for all known forms of life. Its chemical formula is H2O. at standard ambient temperature and pressure. Water moves continually through water cycle of evaporation, transpiration, consolidation, precipitation and infiltration or by runoff usually reaching the sea.

Water covers 71% of the earth's surface, mostly in seas and oceans. Small portions of water (1.7%) occurs as groundwater, in glaciers and the ice caps in Antarctica and Greenland (1.7%) and in the air as vapor, clouds and precipitation(0.001%). Approximately 70% of the freshwater used by humans goes to agriculture. Water is the most important resource which plays the important role in the world's economy.

Drainage Pattern

Drainage pattern is created by stream erosion over time that reveals characteristic of the kind of rocks and geological structures in a landscape region by streams. Drainage pattern is the pattern formed by streams, rivers and lakes in a particular drainage basin. They are governed by the topography of the land, whether a particular region is dominated by hard or soft rocks and the gradient of the land. Drainage patterns may be of five major types namely

1) Trellis drainage - when a consequent stream receives a number of subsequent streams from right or left at approximately right angls to its direction of flow.
2) Dendritic drainage – develops when the stream of different types are all fairly common in a region and none appears to dominate other group.
3) Radial drainage – develops in regions which are either elevated or depressed with reference to the surrounding topography. Naturally from the aerial view streams may be either flowing out from a central elevated region or flowing topwards a common central region when it is depressed.
4) Superimposed drainage – it is developd in geologically old and complex folded regions.
5) Antecedent drainage – the rising block eventually may become a mountain range and the stream may still be flowing through it in a very deeply cut channel of its own.

Watershed

Watershed is a land area that channels rainfall and snowmelt to creeks, streams and rivers and eventually to outflow points such as reservoirs, bays and the ocean. The size of the watershed is defined on several scales- referred to as its Hydrological Unit Codes based on the geography

that is most relevant to its specific area. A watershed can be small, such as a modest inland lake or a single country. All the streams flowing into small rivers, large rivers and eventually into the ocean form an interconnecting network of waterways. Not only water run into the streams and rivers form the surface of the watershed, but water also filters through the soil and some of this water eventually drains into the same streams and rivers. The surface runoff and infiltration are important for a number of reasons. Watershed is of four types namely macro watershed : 1000-10,000 ha ; micro watershed : 100 – 1000 ha; mini watershed : 10 – 100 ha; mille watershed : 1 – 10 ha. The growing abstraction of water has approached

Watershed Management

The word watershed management is used to describe the process of implementing the water management practicals to improve and protect the water resource and also the resources which are in and around the watershed area. This helps in maintaining the quality and quantity of the resource over the watershed area. This contain plannings which helps to prevent pollution over the area. The watershed management leads to several development activities which may contribute even to the country's economy. The watershed management depends upon the type of watershed. Watershed management involves determination of alternate land treatment measures for which information about problems of land, soil, water and vegetation in the watershed is essential. In order to have a practical solution to above problems is necessary to go through four phases for a full scale watershed management.

Objectives

The main objective of this paper is to identify

1. The problems faced due to the water scarcity.
2. The positive outcomes that may happen due to the proper maintenance and management of the watershed.
3. The various uses, maintenance and management of the watersheds are also listed.
4. Various watershed management programmes that are being implemented in India.

Study Area

The area of interest that I have chosen is the India as a whole. India is a one of the developing nations which is one of the South Asian country. It is the seventh largest country by its area and stands in the second position for population. It has the Himalayas as the northern boundary and also shares its north with the boundaries of the adjacent countries like Nepal, Bangladesh, Pakistan and also China to the south it has the Indian ocean and the east and west has Bay of Bengal and Arabian sea respectively. It has a total area of 32,87,263km²by land and 12,69,219sq.mi by water. The Indian currency is said as rupees. It has the time zone of UTC+05:30. It has a various historical movements. It is said as the land of heritage and culture. The world's old civilization said to be Indus valley civilization has its birth place as India.

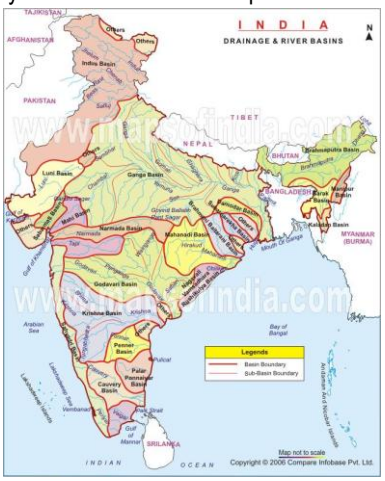

Fig 1: The map showing both the major rivers and basins of India

India is a place where several rivers were flowing in which few of them are perennial rivers. The rivers are covered by flood plains, basins, etc. Further the basins are being divided into several watersheds and most of the irrigations systems are done for the agricultural production. It pays a easy way for the management and the management leads to a healthy agriculture production. This also accomplishes the control of land use practices, afforestation and forest management, and implementation of appropriate soil and water conservation practices.

Uses

Production of food

The very first use which is taken into discussion is production of food. Food is one of the most important thing for survival, maintaining the watersheds may lead to a continuous supply of water to the agricultural lands since the water in the watershed areas would be permanent. Sufficient amount of water would be supplied to all the agricultural land according to its need this may prevent the situation of scarcity.

Pollution control

The runoff water due to precipitation may carry lot of impurities along with it not only the runoff water even the streams and lakes may also contain lots of impurities because of the domestically and industrial wastes. This contaminates the watershed, if watershed management is implemented such impurities and wastes would be removed regularly and the resource would be maintained with a high quality. Such maintenance would lead to a pure environment and the to have a good quality of water.

Minimizing of over exploitation

The concept of minimizing of over exploitation talks about the exploitation of sand from the rivers. If the rivers (watershed) are maintained properly and regularly then the exploitations which are now made illegally would be totally minimized and the resource would me protected.

Water storage

Maintaining the watershed has its primary use of storing the water. Storing the water is one of the best solution for today's water problems. Storing the water may help in the summer season and only by storing the water all of our need would be satisfied.

Flood control

This is one of the most important use of watershed management is flood control. If the maintenance is done properly then the water present in the watershed area will be circulated in a proper way. If it is maintained then the over amount of water present in the area will be distributed equally and the water level in the watershed area would be in a safe level.

Wildlife preservation

When the watersheds are maintained in a proper way then the area around it would be very prosperous and so the wild animals in and around the area would be able to get the sufficient amount of water for their survival. Most of the wild animals are in their end due to hunger and lack of water. This scenario will be changed and reversed if the watersheds are maintained as their will be water in all the water sources and so the animals may be provided with their water requirements.

Erosion control

The possible way for controlling the erosion is planting trees, in such way if the watersheds are maintained in a regular and proper way then the growth of trees would be in a high rate. When the trees are in a high amount the erosion of soil will be reduced in a high way since the roots would hold the soil too tight. Thus the watershed management will lead to the control of soil erosion.

Employment generation

One of the major issues of the country is unemployment. If a separate department is set up for the management of watersheds will be able to create lot of postings in the department and so the employment opportunities would be developed in a high rate.

Groundwater recharge

One of the most important positive effects of watershed management is groundwater recharge. When the watershed areas are maintained properly and regularly then the water in and around the area will be infiltrated in a regular manner which may make the aquifer to be filled up. The filling up of aquifer leads the rise in water table. The rise of water table indicates the increase of freshwater at the particular area. Since all the area on the earth surface comes under anyone of the watershed area surly all the area will be filled with freshwater.

Development programmes

Drought Prone Area Programme (DPAP)

This was started in the year of 1970-1971. The main objective of the programme is development of area through the restoration of ecological balance and optimum utilization of land, water, livestock and human resources to mitigate the effect of drought.

Desert Development Programme (DDP)

The main objective of this programme is to mitigate the effect of drought in the desert area and to restore ecological balance. This programme was started in the year of 1977-1978.

National Watershed Development Programme for Rainfed Agriculture (NWDPRA)

1986-87 was the year of star of the programme. To conserve and utilize rain water from both arable and non arable lands on watershed basis. To increase the productivity of crops and to increase the fuel, fodder and fruit resource through appropriate alternate landuse system was the main objective of the programme.

Control of Shifting Cultivation

Restoring ecological balance in hilly areas and improving socioeconomic conditions is the aim of the programme and the programme was started in the year of 1986-1987.

World Bank Assisted Integrated Watershed Development Project

This was started in the year of 1990. The main objective of the programme is to arrest the problems of environmental degradation and promote sustainable increase in agriculture production and to enhance vegetative technology of soil and water conservation for rain water conservation and for increasing crop, forage, fuel wood and timber yield of the area.

Result

It would be resulting with several positive impacts that helps to improve our quality and quantity of the resources. Some of the various results are listed below,

- The production of food would be increased in a large amount.
- Most of the impurities would be removed and so water pollution would be controlled.
- Due to proper maintenance most of the illegal exploitations would be reduced.
- Requirement of water would be fulfilled because of storing the water.
- Over flow of water would be controlled as the circulation of water will be in a regular way and so the probability of flood would be less.
- Soil erosion would be prevented in a high rate since the growth of trees would be more.
- Unemployment will be reduced as the number of postings will be increased by introducing new postings for this work.
- Major result is the increase of water table.

Conclusion

This may be concluded that if the maintenance of the watershed is done in a proper way then the above mentioned results would be obtained and so this may lead the country in both social and economy development. Thus we the set up of watershed management is a very essential one of the times in order to face the threatening issue of the today's world- water scarcity. This starts right from our home just by maintaining our own water sources.

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THE CATASTROPHIC KERALA FLOODS: IN RETROSPECT

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Abstract

World has been rapidly evolving with new trends in weather patterns. Past few decades have seen an increase in global warming, contamination of land and soil, rise in the sea-level among other issues. But the most disturbing issue of all of the above mentioned is the water crisis. The earth and its inhabitants are becoming more and more vulnerable to man-made and natural disasters. The recent depression in Kerala is one of the foremost examples of how man and nature have both brought havoc to the state. In this paper, an attempt is made to study the causes and impact of the unprecedented rainfall resulting in flood situation at Kerala leading to death toll, damage and destruction to properties, outbreak of diseases and so on.

***Keywords**: Floods, unprecedented rainfall, death tolls, diseases.*

Introduction

Kerala is the southernmost state on the Tropical Malabar coast of India, which has nearly 600km of Arabian Sea shoreline. In August 2018, severe flooding affected the State of Kerala due to unusually high rainfall during the monsoon season. It was the worst flooding in Kerala for nearly a century. According to the Kerala government, one-sixth of the total population of Kerala has been directly affected by the floods and related incidents. The Union government had declared it a 'Level 3 Calamity' or 'Calamity of a severe nature'. Floods in Kerala are said to be caused by heavy rains but that was not only the reason that contributed to the floods. Various other factors were also responsible for the heavy flooding in Kerala.

Scope of the study

The study reflects on critical issues relating to flooding in Kerala such as the causes and impacts. It recognizes the need for the measures to be taken by the Government in the future. It also specifies the tragic situation a single disaster can cause.

Objectives of the study

1. To study the causes for the flood situation in Kerala.
2. To analyze the impact of heavy rainfall in Kerala.

Review of literature

Kadave, Kale and **Narwade (2016)** in their article **"Mumbai Floods, Reasons and solutions"** analyzed the reasons for flooding in Mumbai which recurs almost every year. Floods in Mumbai are said to be caused by heavy rains accompanied by high tides but there are various other reasons which are responsible for the heavy flooding in Mumbai. The study also focused on understanding the effect of floods at Mumbai. The study came to a conclusion stating that rainwater harvesting could be implemented to prevent soil erosion and it found that the flow of the rainwater could not be regulated thoroughly because of an inefficient drainage system in the city.

Diman and **Tahir (2012)** in their research study **"Dam Flooding caused a Prolonged Flooding"** explained the potential of dam flooding to enable the authorities to ensure human safety. They found out that dam flooding and prolonged flooding has directly displaced thousands of people and poses a public health threat. Although according to hydrological assessment, chances of flooding from dams are very small, understanding where water could go or dam flood routing map is the only way to protect the lives and property of downstream residents.

Causes for the flood situation in Kerala

There are two different causes for the killer-flood situation in Kerala- natural and man-made.

- *Natural causes:*

Kerala received heavy monsoon rainfall which was about 257 percent more than the usual rain falling in Kerala, resulting in dams filling to capacity. Almost all dams have been opened since the water level rose close to overflow level due to heavy rainfall, flooding low-lying areas first. For the first time in the State's history, 35 of its 54 dams opened. Recent research done by Roxy, Ghosh and Subimal (2017) states that rising temperatures have led to huge fluctuations in the monsoon winds carrying the moisture from the Arabian sea, resulting in heavy-to-extreme rains over the Western Ghats and Central India lasting for more than three days.

Distribution of Rainfall in Kerala
Information on distribution of rainfall in Kerala: Table 1

District	Rainfall (mm)	Normal (mm)	% increase
Alappuzha	1648.1	1309.5	29%
Ernakulam	2305.9	1606.0	48%
Idukki	3211.1	1749.1	89%
Kannur	2450.9	2234.9	10%
Kasaragod	22549.94	2489.1	12%
Kollam	1427.3	985.4	51%
Kottayam	2137.6	1452.6	50%
Kozhikode	2796.4	2156.5	30%
Malappuram	2529.8	1687.3	52%
Palakkad	2135.0	1254.2	75%
Pathanamthitta	1762.7	1287.5	44%
Thiruvananthapuram	920.8	643.0	45%
Thrissur	1894.5	1738.2	16%
Wayanad	2676.8	2167.2	26%
Kerala	**2226.4**	**1620.0**	**41%**

Source: Customized Rainfall Information system (CRIS) www.hydro.imd.gov.in

Table 1 shows that in the districts of Idukki and Palakkad, there has been a drastic increase in rainfall of 89% and 75% respectively. These districts have been hit by the floods disastrously. The other district which has faced serious damage was Ernakulam. This was mainly because of the city's improper drainage system and congested planning of town area. Kollam, Kottayam and Malappuram districts also suffered highly. There were many people who lost their lives. Some lost their properties while others' houses were damaged beyond repair. The districts of Kannur and Kasargod were the only ones least affected by the floods having only an increase of 10% and 12% increase in distribution of rainfall.

Man-made causes

The second reason for the flood situation which arose in Kerala was the man-made disasters. The Western Ghats Ecology Expert Panel also known as Gadgil commission, after it's Chairman Madhav Gadgil, an environmental research commission appointed by the Ministry of Environment and Forests of India submitted its report to the Government of India on 2011. But the report was severely criticized for being too environment-friendly. The Gadgil panel recommended a blanket approach which consisted of guidelines for sector-wise activities, which could be permitted in the ecologically sensitive zones of Kerala. The report stated that "the Western Ghats is a biological treasure trove that is endangered, and it needs to be protected and regenerated, indeed celebrated for its enormous wealth of endemic species and natural beauty." However most of the regions which were affected by this killer-floods were classified as Ecologically-Sensitive Zones (ESZs) by the Western Ghats Ecology Expert Panel, the Gadgil Committee.

The places including Idukki, Kozhikode and Kannur, where the landslides have been hit at the worst way were already considered as ESZs. This was because in these places, the greedy men were constructed the buildings in wetlands, so the water didn't have any place to drain, which resulted in the flood situation. And when we take the cities, for instance, Kochi in the state of Kerala, that had been totally flooded, it was found out that major parts of the city had been either built or expanded on levelled farmlands, which therefore blocked the waterways. Another man-made cause which led to the flood situation in Kerala was the use of explosives to blast rocks in quarries. This led to rapid ecological changes which triggered landslides. Diman and Tahir (2012) in their study stated that large number of unauthorized construction on river-beds will be a human blunder which can lead to the food situations anywhere. The deforestation was another important man-made cause for the flood situation. This is because trees prevent sediment runoffs and forests hold more water than farms or grasslands. So the trees play an important role in the flooding equations. Local officials are also a reason for exacerbating the situation by failing to open the dams gradually and slowly. The dam operators could have started releasing the water in advance rather than waiting for it to be filled up, when they have no other alternative but to release water.

Impact of heavy rainfalls at Kerala

***Loss of lives*:**

The Kerala flood disaster claimed more than 500 lives and the estimated value of destruction was more than the annual outlay of the state. There were almost 14.50 lakh people in more than 3,000 relief camps. A total of 57000 hectares of agricultural crops was destroyed. Although the Meteorological Department gave adequate warnings regarding the rains, the unprecedented showers led to a deluge. Dams in the state were overflowing and was the primary reason for this tragedy.

***Other impacts*:**

i. Financial impact: The trail of devastation left by recent floods in Kerala, according to the initial estimates, property worth more than Rs.20,000 crores was lost and insurance companies

received claims worth more than Rs.1000 crores. While the floods wreaked havoc on the finances of people living in the state, they also had an impact on the portfolios of thousands of others elsewhere as stocks of companies with links to Kerala was affected. With the focus shifting to rebuilding, there was a fall in demand for immediate consumption and Onam sales were a total washout. As a result, gold business suffered a tragic loss.

ii. Decline in Tourism: After the devastating floods, Kerala saw a fall in the number of tourists. There was 4-5% decrease in the tourism sector of the state. The busiest airport in Kochi was shut for 2 weeks because the place was in waters. This area accounts for 52% of all the tourism in the state. The Cochin International Airport was also shut down for many days due to heavy rainfall and extremely bad weather conditions. This was the main reason which led to the decline of tourism due to the killer foods at Kerala.

iii. Rubber price surge: Rubber prices in India were stable throughout the year, suddenly surged by 5% as flood hit Kerala. With Kerala having a near monopoly on India's Rubber output, incessant rains and flooding left the industry in doldrums. There was a devastation of acres of rubber plantation which affected the production and disrupted the supply of rubber. The prime production centers of rubber, Idukki and Kottayam districts were tragically affected by the killer floods.

iv. Transport and Power Sector: Kerala's power and infrastructure with telecom connectivity are bearing the brunt of the worst floods in a century for the coastal state. All the train traffic between Trivandrum and Ernakulam via Kottayam remains suspended for two weeks. More than 10, 000 Kms of National and State Highways and also parts of Panchayat roads totaling around 65, 000 Kms were damaged.

Electricity supplies were also affected when the state's maximum met power came down to 2241 megawatt (MW) compared with the actual supply which was 3136 MW. More than 4000 electricity transformers were switched off according to the State Government which created a power outage. Lack of electricity also affected telecom services across the state, mainly in the flood affected low lying areas such as Idukki, Wayanad and Ernakulam. Initial damages exceeded Rs.50,000 crores, according to State Government's assessment.

v. Outbreak of Diseases: Kerala started battling an outbreak of a bacterial disease called Rat Fever since mid august of 2018. There was a 200 confirmed cases of Rat Fever out of which 9 deaths were confirmed. The surge in the cases came after the torrential rain. Leptospirosis, a rare disease which only occurs during monsoon season especially for farmers through wounds such as cuts when their paddy fields fill with water, were seen spreading in Kozhikode and Wayanad causing the death of more than 30 people. This was an unusual case because the disease affected not only the farmers but also common people. The reason behind this was mainly due to the killer floods of Kerala. The State declared a health alert after the increase in the death toll. The State also saw a rise in the cases of other water borne diseases such as Cholera, Typhoid, Diarrhoea and Hepatitis.

Conclusion and suggestions

Quarrying and construction of buildings in landslide-prone areas should be prohibited by the Government. Emergency flood proofing has to be put into effect at a short notice. Methods commonly used for this include building temporary embankments, levees or barriers using materials which are easily accessible during the flooding. Surviving the flood is also very important. One major way to make sure of this is to keep the emergency kit safe and dry. There are also ways to reduce the future flooding and its impacts. Some of them are as follows:

- Plant trees around the houses and in common areas to prevent erosion.
- Stop throwing wastes and rubbish in the river bodies and canals.
- Do not throw plastic or any non-biodegradable objects anywhere which may clog or block the drainage system thereby impending the flow of water.
- Support community activities intended to lessen effects of floods.

- Donor governments and agencies should be encouraged to continue and increase their rapid funding for the speedy recovery of the victims.
- Public awareness and public participation on flood prevention and crisis is also another practice which should be taken into account.

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GENDER AND WATER: ASSESSING WOMEN'S WORK BURDEN IN DOMESTIC WATER COLLECTION

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Abstract

Water is one of the most important renewable natural resources for supporting life. Due to cultural and historic reasons, women are often the primary collectors, transporters and users of water in developing countries. They tend to have the main responsibility for health, child care and are managers of domestic water as well as promoters of home and community based sanitation activities. This division of labour generally results in women's and men's different priorities for water use and management. Yet, in many societies women's views are not systematically represented in decision-making bodies, and gender-based inequalities are often made invisible in debates and cultural norms. Women have accumulated knowledge about water resources, including location, quality and storage methods, as well as insights in common habits and problems within a community, which are important information for programming. Based on simple random sampling, primary data was collected from a sample of 24 households from Ooty. The researcher has also made use of secondary data to look into the knowledge, involvement, and contribution of women in water as well as issues faced by them.

Keywords: *women, gender, water, sanitation*

Introduction

Water is one of the most important renewable natural resources for supporting life. In most societies, women have primary responsibility for management of household water supply, sanitation and health. Water is necessary not only for drinking, but also for food production and preparation, care of domestic animals, personal hygiene, care of the sick, cleaning, washing and waste disposal. Because of their dependence on water resources, women have accumulated considerable knowledge about water resources, including location, quality and storage methods. However, efforts geared towards improving the management of the world's finite water resources and extending access to safe drinking water and adequate sanitation, often overlook the central role of women in water management.

In India, 16 percent of the world's population, has only 2.5 percent of the world's land area and 4 percent of the world's water resources at its disposal. Precipitation in the form of rain and snowfall provide over 4,000 trillion litres of fresh water to India. Most of this freshwater returns to the seas and ocean via the many large rivers flowing across the subcontinent. A portion of this water is absorbed by the soil and is stored in underground aquifers. A much smaller percentage is stored in inland water bodies both natural (lakes and ponds) and man-made (tanks and reservoirs). Of the 1,869 trillion litres of water reserves, only an estimated 1,122 trillion litres can be exploited due to topographic constraints and distribution effects. The demand for water has been increasing at a high pace in the past few decades. The current consumption in the country is approximately 581 trillion litres with irrigation requirements accounting for a staggering 89 percent followed by domestic use at 7 percent and industrial use at 4 percent. Hence, women's active participation in water and sanitation solutions can improve health, improve status, increase women's safety, creating opportunities for income generation, as well as providing them with other public and influential roles.

Research Problem

Given that women are the main participants in domestic water provision. The collection, storage and provision of water at family level are the responsibilities of the women in most developing societies. Concerns about water, the economics of saving water, domestic consumption, sanitary purposes, industrial purposes and agricultural purposes are all fundamental issues that women are familiar with. The gap between men and women in terms of ownership or control, representation and access to water resources needs to be addressed. Women continue to be excluded from effective participation in water issues, yet it is women and children that are most vulnerable to water related disasters. The 108nderutilization of women's skills makes it hard for them to use those skills to better their lives. Addressing the meaningful participation of women is important to ensure

that decisions on water as a basic right are made by all those involved rather than being left to men alone.

Research Objectives

- Role of women in water
- Problems faced by women farmers and household women due to water
- Gender issues related to water
- Water resource management by women
- Solutions for the problems

Research Methodology

Semi-structured household questionnaires: Semi-structured household questionnaires were used to investigate aspects of water use and consumption; to learn about changes in water-use practices, household occupations, and sources of water; and to cross-check certain findings and note variations in comparison with village-level discussions. Semi-structured questionnaires with women provided detailed insights into the daily tasks of domestic water collection, how these changed when traditional water sources were eliminated, and how new water sources generated new expectations and water uses. About 24 women were asked to fill the questionnaires in the villages in and around Ooty. The researcher used convenience sampling.

The Role of Women in Water

While accessible water resources are adequate at global levels to meet the water needs of the world, they are unevenly distributed, with particularly low per capita resources in the Southern Asian regions. By 2050 water use by agriculture and industry is projected to increase by 19 percent. Household women collect water for household purposes like washing clothes, washing vessels, cooking, etc. and rural women fetch water for both household and agricultural purposes like irrigation, animals, etc. The most affected are marginalized local communities and particularly rural women, who carry a great part of the burden of providing water for household domestic uses: in one day more than 152 million hours of women and girls' time is spent collecting water for domestic use. Women are often the primary collectors, transporters and users of water in developing countries. They tend to have the main responsibility for health, child care and are managers of domestic water as well as promoters of home and community based sanitation activities. Women have accumulated knowledge about water resources, including location, quality and storage methods, as well as insights in common habits and problems within a community, which are important information for programming. Out of 24 households questioned by the researcher, 23 adult women go for fetching water (approx. 96%) and 1 adult male go for fetching water (approx. 4%)

Table 1 Gender wise analysis of fetching water

Gender	Frequency	Percentage (approx)
Women	23	96
Men	1	4
Total	**24**	**100**

(Source: primary data)

Problems faced by women

1. **Freedom from imprisonment by daylight:**

   In many cultures, the only time available for women or girls to defecate, if they don't have a latrine, is after dark. Apart from the discomfort caused by the long wait, this can cause serious illness. And there is also a risk of harassment and assault during the night-time walk to and from the communal defecation fields.

2. **School enrolment and attendance:**

   The lack of safe, separate and private sanitation and washing facilities in schools is one of the main factors preventing girls from attending school, particularly when menstruating.

3. **Reduce the burden of caring for the sick:**

   The health and lives of more than half the world's children are constantly threatened by environmental hazards as they get sick through contact with excreta in their environment. Caring for sick children adds to the already heavy workload of women and girls.

4. **Protect pregnant women from diseases:**

   About 44 million pregnant women have sanitation-related hookworm infections that pose a considerable health burden in developing societies. The burden is even heavier for women who are pregnant or are also carrying small children. Moreover, pregnant women worry that transporting these heavy loads will lead to early labor or even miscarriage.

5. **Heavy loads:**

   Water is heavy. The WHO recommends 20-50 litres of water per person per day for drinking, cooking, and washing. That amounts to hauling between 44 and 110 pounds of water daily for use by each household member.

6. **More distance:**

In the below Table-2, nearly 13 persons (i.e., the majority) goes 1-5km to fetch water and 6km women. In many places, water sources are far from homes. In Asia and Africa, women walk an average of 3.7 miles per day collecting water. Carrying such loads over long distances can result in strained backs, shoulders, and necks, and other injuries if women have to walk over uneven and steep terrain or on busy roads.

Table 2 The distance in fetching of water

Distance	Time Taken	Frequency	Percentage (approx)
Close by	1-10mins	6	25
1-5 km	10-30mins	13	54
5-10 km	More than 30mins	5	21
Total		**24**	**100**

(Source: Primary data)

7. **Lost hours:**

In the above table, those water sources in the distance of 1-5km walk for 10-30mins and 5-10km walk for more than 30mins. Collecting water takes time. Simply to get water for drinking, bathing, cooking, and other household needs, millions of women and girls spend hours every day travelling to water sources, waiting in line, and carrying heavy loads–often several times a day.

8. **Lack of women's development**

It is also found that most women get so busy with their daily household work (cooking, cleaning, washing, collecting water, raising livestock, including agricultural activities like as weeding, ploughing etc.) that they do not get time to go for other activities that can help them to earn some money. The Government has come up with many schemes and employment opportunities for girls and women, yet it is still to reach the remotest of villages.

Gender issues

One of the most observable divides between women and men, especially in developing countries, is in sanitation and hygiene. The provision of hygiene and sanitation are often considered women's tasks. Women are promoters, educators and leaders of home and community-based sanitation practices. However, women's concerns are rarely addressed as societal barriers often restrict women's involvement in decisions regarding toilets, sanitation program and projects. And in many societies, women's views, as opposed to those of men, are systematically under-represented in decision-making bodies. Women and children often bear the brunt of the lack of toilets and other sanitation facilities. Women, more than men, suffer the indignity of being forced to defecate and urinate in the open, where they often have to walk to remote locations outside the village leaving women vulnerable to assault and potential rape (COHRE et al. 2008). The majority of those using public defecation areas, where hygienic conditions are often poor and disease is close, are women. In the absence of sanitary facilities, women often have to wait until dark to go for toilet. That is why women often drink less, causing all kinds of health problems. Attempting to 'hold out' until the evening may result in physical harm, such as urinary tract infections. People may also attempt to modify their diets, by not eating certain fibrous foods such as pulses or leafy vegetables. An unbalanced diet may result in negative long-term health consequences.

In rural areas of many regions, men often do not use stinky pit latrines and relieve themselves in the open, whereas women are dependent on the pit latrines several times a day. In urban areas women and girls face innumerable security risks and other dangers when they use toilets shared with men. With the lack of safe sanitation women's dignity, safety and health are at stake. Whereas the cleaning of toilets is primarily the responsibility of women, construction and maintenance of pit latrines (digging, repairing and exhausting) is primarily done by men (Hannan and Andersson 2002). However, in some regions, the task of emptying the latrines falls exclusively on the shoulders of poor women, and the labour-conditions under which they do this work are appalling. In many households, women are also responsible for making sure there is sufficient water for sanitation and there are many cases where women have to pay for water from limited household budgets. Despite the role of women in hygiene and sanitation at household level, toilet construction program that provide income-generation opportunities often presume that only men will be interested in or suited for those tasks.

Girls, particularly at and after puberty, do miss school or even drop out of their schools due to the lack of sanitary facilities, and/or the absence of separation of girls' and boys' toilets. In these situations, girls also stay away from school when they are menstruating (Hannan and Andersson 2002). In rural Pakistan for instance, more than 50% of girls drop out of school in grade 2-3 because the schools do not have latrines (UNICEF, 2008)

Water resource management by Women

Women's reproductive roles: The term reproductive is used here in the sense of social rather than biological reproduction. It refers to all of the services provided by women to ensure the healthy maintenance of their families, including cooking, cleaning, and child care. Because reliable and convenient access to potable water is important in helping women fulfill these tasks, donors and governments often assume that women's primary strategic interest in water relates to their domestic roles. Significant research on women and water has been undertaken from this perspective, focusing especially on:

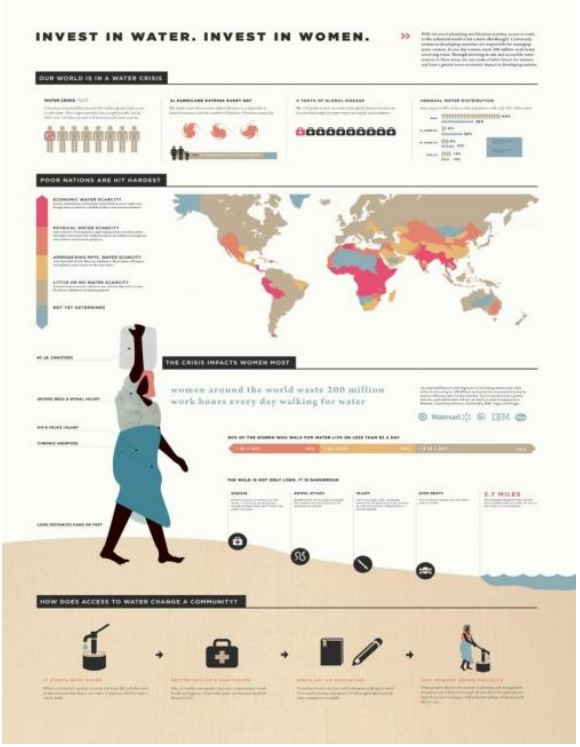
- Access to water;
- Decision-making related to water use; and
- Family health and water and sanitation.

Hence, women's active participation in water and sanitation solutions can improve health, improve status, increase women's safety, creating opportunities for income generation, as well as providing them with other public and influential roles.

Solutions

To mitigate the women water burden, a few measures can be adopted:

- Restore the conventional methods of water conservation like Baolis, Jhods, Ponds, Tankas.
- Introduce rainwater harvesting.
- Change the cropping pattern of agriculture. Instead of growing water intensive crop like paddy and sugarcane, introduce crops like millet, ragi, which consume less water.
- Proper water conservation measures should be used. People should be made aware and trained on the techniques of water conservation.
- Government schemes should be implemented properly.
- Involve Panchayat Raj Institutions (PRIs) and NGOs in the management of rural water supply.
- Women should have community control over water. So that they can manage water for the sustainability of the eco-system, their families and villages. They should be trained as water managers for the better utilisation of water.



Conclusion

There is a critical need to reduce the amount of time that women and children spend collecting water. Accessibility to water, water collection by children, and gender ratios for water collection, especially when collection times are great, should be considered as key indicators for measuring progress in the water, sanitation, and hygiene sector. If women have improved access to water for both domestic use and agriculture production, they can have more time to start market gardens or income generating activities, and in-turn improve the diet and incomes of their households, as well as become more involved in the governance structures that shape communities.

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WOMEN, WATER AND DEVELOPMENT

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Abstract

With increased population and urbanization, the need of water for consumption, irrigation and manufacturing has exponentially expanded. Water, which was once available free, has now become an economic good. All these changes have greatly impacted the feminine gender of the human population. With the 21st century woman already facing many problems, the problem of water scarcity is imposing added pressure on womanhood. This paper analyses the inter-related problems between women and water availability and tries to formulate practical solutions for the betterment of water resources and womankind.

***Keywords**: Women, water, development, water resource management.*

Introduction

"Neerindri amaiyadhu ulagenin yaaryaarukkum
Vanindru amaiyathu ulagu."- Thirukkural, Adhigaram-2.

We are living in an era of gender equality. Women have fought for many centuries to earn their respectful right to come out of their homes and stand on their own feet. Women feel the increasing urge to be politically, economically and socially independent. Though women have overcome all the artificial restrictions imposed on them by the patriarchal society, they are not able to surmount the restraints levied by Mother Nature. One such check is water scarcity.

Women Workforce- Still on the Verge of Development:

The feminine gender constitutes about 58.6 crore of the total population in India. But out of this humongous number, only 24.8 percent in the rural India and 14.7 percent of urban women are employed(2011 Census). This is a really concerning data, considering that India is at its peak period where the working population is relatively high when compared to other countries. This gives us a natural advantage over other countries, as an increased ratio of working population automatically increases the growth and development rate of India.

But in reality, this natural benefit has not been fully realised by the Indian economy, especially in the field of women workforce. A World Bank report says that the contribution of the Indian workforce of women is just 17 percent of the total GDP of India. The problem is even more aggravating with the passing of every year, as the ratio of working rural women is on the decrease, while the urban working force is stable.

Table 1 Women workforce participation rate

Year	Rural india	Urban india
2000-2001	28.7	14.0
2001-2002	31.4	13.9
2002	28.1	14.0
2004-2005	32.7	16.6
2005-2006	31.0	14.3
2007-2008	28.9	13.8
2009-2010	26.1	13.8
2011-2012	24.8	14.7

Source: 2011 Census

One of the main reasons for the fall in the ratio of women workforce in rural areas is the decreased amount of monsoons. With the increasing water scarcity, women are in search of water sources, both for domestic and agricultural purposes.

Table 2 Annual monthly rainfall in MM

Year	Rainfall
2001	1100.7
2002	935.9
2004	1106.5
2005	1208.3
2006	1161.6
2007	1179.3
2008	1118
2009	953.7
2010	1215.5
2011	1116.3

Source: Ministry of Earth Sciences and India Metrological Department

If we observe the above tables (1) and (2), we can clearly say that the rainfall amount has certainly affected the women workforce of India. Thus, we can conclude that the availability of water surely has an impact over rural women. But from the same tables, we can also identify that the urban women workforce has remained almost stable, despite the fluctuations in the monsoons. In this background, a study has been undertaken to understand the attitude of urban women towards water.

Objectives

- To get a clear picture of the water availability.
- To know the attitude of working women towards water.
- To know the water consumption patterns of urban households.
- To understand the effects of water on the socio-economic conditions of urban women.

Methodology

The survey was conducted among 25 employed urban women scattered all over Coimbatore. The sample was restricted to 25 due to time constraints.

Findings

A. Water availability

Out of the 25 houses surveyed, nearly 92 percent had individual pipe connections and only 8 percent had to fetch water from a common point.

B. Attitude of women towards water availability:

Table 3

Parameters	SA	A	N	DA	SDA	Total
Proper supply of clean water is one of the reasons for economic development.	14	9	1	1	0	25
Availability of clean water helps to live a healthy life free from water borne diseases.	20	5	0	0	0	25
When the sources of water are near my home, I feel less burdened and it saves time.	18	7	0	0	0	25
Supply of water at regular intervals reduces my stress.	11	13	1	0	0	25
Proper supply of water empowers me.	7	14	3	1	0	25
My parents got me married to my husband because his place ensured proper supply of clean water.	3	7	11	4	0	25
I talk to my children about the importance of water.	8	11	6	0	0	25
I insisted on installing Rain Water Harvesting system at my home.	6	6	9	4	0	25
Scarcity of water gives both physical and mental burden to the women more than men.	16	8	0	1	0	25
Clean food helps to prepare nutritious food for my family.	19	6	0	0	0	25

Abbreviations

SA- Strongly agree
A-Agree
N-Neutral
DA-Disagree
SDA-Strongly disagree

Interpretations

- 56 percent of the surveyed women strongly agreed and 36 percent agreed that proper supply of water is one of the sources of economic development.
- 80 percent strongly agreed that clean water is essential for a healthy life.
- The above results show that when the sources of water are near the home and water is supplied at regular intervals, the stress of women is reduced to a very great extent.
- We can clearly observe that there is no very close relationship between water supply and marriage in urban areas, with 44 percent remaining neutral.
- Finally, 64 percent of women strongly agreed that water scarcity has more impact on women more than men.

C. Usage of water

Table 4 Sample urban households

Gender	Usage of water	
	Less	More
Male	5	13
Female	17	8
Both male and female	3	4
Total	**25**	**25**

Interpretation

- Out of the total sample, 68 percent of the women told that women use less water than men and 52 percent told that men waste more water in the urban households.

Table 5 Water Management

Parameters	Yes	No	Total
I pour the waste water from washing vegetables, rice and others to the plants in the garden.	18	7	25
I divert the water from washing machine to your garden.	12	13	25
I play a dominant role in managing the use of water at home.	23	2	25
If there is scarcity of water, I will restrict my water intake.	16	9	25
I wash the clothes by hand because washing machine consumes lots of water.	14	11	25
Women use less water than men.	16	9	25

Interpretation:

From the above table, we can opine that in 92 percent households, women manage the usage of water. About 72 percent of the women pour the water from washing vegetables and rice to the plants. On the other hand, only 48 percent divert the water from washing machine to their garden. Surprisingly, 56 percent try to reduce the usage of washing machines as it consumes more water.

D. Water and its effects on the socio-economic development of urban women:

Table 6

Parameters	Yes	No	Total
If there is not proper supply of water at home, I will be unemployed.	7	18	25
Even if there is no proper supply of water at schools, I will send my girl children to study after puberty.	19	6	25

Interpretations

Out of the 25 women, 28 percent told that they will be unemployed in situations of scarcity of water. Another interesting data found is that only 24 percent will not send their girl children to formal schools in case of water scarcity.

Other findings

1. 7 women answered that they will not go to work in periods of water scarcity. But out of them, 42 percent told that they will do all those kinds of jobs which can be done from home, 14 percent was ready to migrate, and 42 percent told that they will depend on their family members for money.
2. Similarly, 76 percent women were ready to send their girl children to schools after puberty either by sending them to hostels or by migrating to places of good water supply.
3. At the same time, the women who told that they will not send their girls to school after puberty in case of water scarcity, assured that they will ensure their daughter's economic development through imparting traditional hand skills or through distance education.
4. 52 percent women told that they will send their children of both genders to fetch water from far off places, 36 percent opined that they will send only their male heir to fetch water and only 12 percent were ready to send their girls to fetch water.

These findings support the stability of urban working population of women even in years of water scarcity.

Inclusion of women in rural areas through Integrated Water Resource Management:

From the above observations, some solutions have been arrived at for increasing the rural workforce. They are:

- All houses in rural areas should be facilitated with individual water pipes.
- Grey water treatment plants should be installed so that the treatable waste water from households can be diverted to agricultural lands for irrigation.
- More awareness should be spread among people about waste water management.

- Clean supply of water and sanitary conditions should be ensured in Government schools so that parents will not be hesitant to send their girl children to school. As said above, even the Government schools should have RWH system and Grey water treatment system.
- The government should mandatorily install Rain Water Harvesting systems in rural areas. But this is impossible in case of kutcha houses, which are predominantly found in rural India. Therefore the Government through special schemes similar to Pradhan Mantri Aawaz Yojana, should increase the number of pucca houses with RWH systems in rural areas.

General suggestions

- The Government should make efforts to divert the treatable waste water from all households to a general Grey water system installed for a specified number of blocks.
- The government should create certain norms and parameters for manufacturers of washing machines and dishwashers in such a way that they consume less water and should be made available at pocket-friendly costs. The government should also ban the use of old washing machines and dishwashers which consume more water.
- Drills should often be conducted in schools to train the young children to avoid unwanted use of water.
- The diameter of faucets should neither be too big nor too small but of the optimum size. The water discharge amount should also be reduced as the contemporary faucets discharge lots of water with just slight turn.
- The men should be made more aware of the optimum use of water.
- The government should make it mandatory to dredge rivers and lakes when water levels are very low in summer season.
- Strict laws should be framed to prevent plundering of sand from rivers and their banks.

Conclusion

Thus only through Integrated Water Resource Management, water use efficiency among Indian households can be increased. Once the aqua infrastructure is regulated and revived, women will be encouraged to pursue their dreams without the burden of water scarcity pulling them back from their path ahead towards economic, social, political and gender equality development.

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WASTE WATER MANAGEMENT

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Abstract

Wastewater management in India has become an extremely important area of focus due to increasing health awareness and population pressure. The treated wastewater is being effectively used in Agricultural irrigation, Landscape irrigation like parks, school yards and Industrial irrigation in heavy construction, cooling water, etc… This paper aims to understand and analyze the concept of wastewater management in order to achieve Sustainable development

Keywords: *Waste Water Management, Sustainable Development*

Introduction

Waste water refers to all the affluent from households, commercial establishments and institutions, industries, hospitals and so on.

Wastewater comes in three main types namely Black water – wastewater that originates from toilet fixtures, dishwashers and food preparation sink and Grey water – wastewater that originates from non-toilet and food fixtures such as bathroom sinks, laundry machines, spas, bathtubs and so on. Types of wastewater include: domestic wastewater from households, municipal wastewater from communities (also called sewage) or industrial wastewater from industrial activities. Sources of wastewater include washing water, Rainfall collected on roofs, yards, urban runoff from highways, roads, car parks, pavements. To make wastewater acceptable for reuse or for returning to the environment, the concentration of contaminants must be reduced to a non-harmful level, usually a standard prescribed by the U.S. Environmental Protection Agency.

Wastewater IN India

The wastewater treatment and management market has picked up pace during the last decade and is in a building stage. Only 21 percentage of wastewater generated is treated in the country and the treated wastewater does not meet the norms and standards for effective reuse.

It is estimated that about 38.254 million liters per day of wastewater is generated in urban centers. The major chunk of wastewater treated is reused Industrial sector and

- There are 35 metropolitan cities (more than 10 Lac Population), 15,644 Millions Liter per Day (MLD) of sewage is generated from these metropolitan cities. The treatment capacity exists for 8040 MLD i.e. 51% is treatment capacity is created.
- Among the Metropolitan cities, Delhi has the maximum treatment capacity that is 2330 MLD (30% of the total treatment capacity of metropolitan cities) Next to Delhi, Mumbai has the capacity of 2130 MLD, which is 26% of total capacity in metropolitan cities.

Wastewater Treatment

Supply of clean, safe and potable water to meet human needs is a great challenge in this era. To achieve this objective wastewater treated and reused. Wastewater treatment is the process of converting wastewater- water that is no longer needed or is no longer suitable for use- into the water that can be discharged back into the environment. There are two wastewater treatment plant namely Chemical/Physical treatment plant and Biological treatment plant. The physical waste treatment plant use chemical reactions as well as physical processes to treat wastewater. These plants are mostly used to treat wastewater from industries, factories and manufacturing firms. Biological waste treatment plants use biological matter and bacteria to break down waste matter. Biological treatment systems are ideal for treating wastewater from households and business premises.

Process of Treating Wastewater

Untreated or improperly treated wastewater contains biological contaminants that can pose health and safety problems. To purify the wastewater, following steps are taken:

Wastewater collection

Collection systems are put in place by municipal administration, home owners as well as business owners to ensure that all the wastewater is collected and directed to a central point. This water is then directed to a treatment

plant using underground drainage systems or by exhauster tracks owned and operated by business people.

Odor control

At the treatment plant, odor control is very important. Wastewater contains a lot of dirty substances that cause a foul smell over time. To ensure that the surrounding areas are free of the foul smell, odor treatment processes are initiated at the treatment plant. All odor sources are contained and treated using chemicals to neutralize the foul smell producing elements. It is the first wastewater treatment plant process and it's very important.

Screening

Screening involves the removal of large objects for example cotton buds, plastics, rags, sanitary items, bottle tops that in one way or another may damage the equipment. Failure to observe this step, results in constant machine and equipment problems. Specially designed equipment is used to get rid of grit that is usually washed down into the sewer lines by rainwater. The solid wastes removed from the wastewater are then transported and disposed off in landfills.

Primary and Secondary treatment

This process involves the separation of macrobiotic solid matter from the wastewater. Primary treatment is done by pouring the wastewater into big tanks for the solid matter to settle at the surface of the tanks. The sludge, the solid waste that settles at the surface of the tanks, is removed by large scrappers and is pushed to the center of the cylindrical tanks and later pumped out of the tanks for further treatment. The remaining water is then pumped for secondary treatment. The secondary treatment stage involves adding seed sludge to the wastewater to ensure that is broken down further.

Bio-solids

The solid matter that settle out after the primary and secondary treatment stages are directed to digesters. The digesters are heated at room temperature. The solid wastes are then treated for a month where they undergo anaerobic digestion.

Tertiary management

This stage is similar to the one used by drinking water treatment plants which clean raw water for drinking purposes. The tertiary treatment stage has the ability to remove up to 99 percent of the impurities from the wastewater. This produces effluent water that is close to drinking water quality.

Disinfection

The disinfection process is an integral part of the treatment process because it guards the health of the animals and the local people who use the water for other purposes. The wastewater must be disinfected for at least 20-25 minutes in tanks that contain a mixture of chlorine and sodium hypochlorite.

Sludge treatment

The sludge that is produced and collected during the primary and secondary treatment processes requires concentration and thickening to enable further processing. It is put into thickening tanks that allow it to settle down and later separates from the water. This process can take up to 24 hours. The sludge is then treated and sent back into the environment and can be used for agricultural use.

Advantages of Reuse of Wastewater

By using wastewater as a resource rather than a aste product you can:

- Economically beneficial
- Addressing the water demand
- Use fewer water resources & save more water
- Diminishes the volume of wastewater discharged, resulting in beneficial impact for aquatic environment
- Irrigate the garden during drought or water restrictions
- In most cases, the quality of the wastewater, as an irrigation supply, is superior to that of well water
- Cut down the amount of pollution going into waterways
- Help save money on new infrastructure for water supplies and wastewater treatment.

Government Initiatives

The Government has taken effective measures to manage and treat the wastewater. Some of the initiatives are as follows:

- Initiating Waste Management Programs - Government has setup JNNURM program to fund cities for developing urban infrastructure and services.

- The Government has launched a web application in 2016 to track the status of various kinds of wastes generated in India.
- Solid waste policy – It specifies the duties and responsibilities for hygienic waste management for cities and citizens in India. This policy was framed in September 2000, based on the March 1999 Report of Committee for Solid Waste Management
- Budget expansion – Plan outlay for the Ministry of New and Renewable Energy has increased by 61 percentage from 99M (Euro) in 2009-10 to 160 (Euro) in 2010-11

Conclusion

This paper gives an overview of what and how is wastewater managed. Wastewater, properly treated, is a source of water for many purposes. Wastewater management is relatively low in India compared to other countries. But it is necessary to adopt the approach of Reuse, Recycle and Discharge to decrease environmental pollution and to reach the water demands.

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WATER - A LIFE SUSTAINING AND DETRIMENTAL ELEMENT OF WOMEN

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Abstract

Water, a free gift of nature has now become an economic good due to its scarcity. This is mainly due to the uncontrolled and greedy use of water by the people. Water consumption has tripled globally in the last 50 years. The causes may be climatic changes, changes in land use and energy generation. These causes often hinder the supply of adequate water in the urban as well as the rural areas. The only difference is that in the village's people hunt for wells and the city-dwellers hunt for water Lorries and bore-wells. This situation has intensified in the recent years. Women and water have a very unique relationship from the consumption of water to its saving. This paper portrays the sufferings of women in fetching the water from the wells and rivers in the villages, their role in the conservation of water and the suggestions for the betterment of their lives.

Introduction

Water, a free gift of nature has now become an economic good due to its scarcity. This is mainly due to the uncontrolled and greedy use of water by the people. Water consumption has tripled globally in the last 50 years. The causes may be climatic changes, changes in land use and energy generation. Tamil Nadu has been forced to use water as an economic good mainly due to the fact that there are inadequate storage facilities to conserve the water in times of floods. We experience both the situation of floods and droughts. The water during floods merges with the sea water turning useless for consumption. In 2005 nearly 349 tmc of water went into the sea due to this reason [Kissan World Magazine, Nandhini Consultancy Centre]

The life of the people gets shattered due to these disasters. It has a highly adverse effect on women than on men. From fetching the water from the wells to suffering during disasters, women have a great part than men.

Objectives

This paper portrays the sufferings of women in fetching the water from the wells and rivers in the villages, their role in the conservation of water and the suggestions for the betterment of their lives.

Water Fetchers

In the ancient days women had a routine of fetching water from far away wells and rivers for their daily consumption. This water was the base for various activities like cooking, bathing, etc.. People had to trek miles to fetch water and often women were the ones to bring water for their whole family. In the scorching heat of the sun they neither had time to take water leisurely nor had an aid from their men. They carried gallons of water everyday which would obviously be too heavy to lift. Not only did grown up women struggle but also the little girl children who were forced to this crisis. This issue has not yet been solved in many of the Indian villages and still people are forced to trek miles a day for the sake of water.

Illustration

There is a recent incident that can exactly illustrate the present scenario. Malkangiri, a tribal district is a good example of a place where people run for miles even today to fetch water in a temperature exceeding 40 degree Celsius. The water in most places is either dried up or contaminated. The only option they have is to walk 2 to 3 kms every morning. Even this distant source does not ensure a consistent supply of water as they get dried up and so people are forced to rely on contaminated sources. [The Indian Express, 22nd April 2017]

Chief Victims of the Natural Calamities

Women not only suffer in times of scarcity of water but also in times of floods. During a flood, women suffer greater than men as their basic requirements are difficult to be procured. During the Chennai floods, women with their monthly sickness suffered a lot because of lack of adequate sanitation facilities. Even the pregnant women in these flood affected areas had to be rescued by helicopters which may not be an easy and quick job. Most women and children often require the help of a man even to rescue their lives. This situation can also be traced in

the recent floods in Kerala. These disasters almost paralysed the lives of the victims. This situation can be traced even during their normal lives where they strive for their sanitation. It has been estimated that women without toilet facilities spend 97 billion hours every year in just searching for toilets for their sanitary needs. [https://www.livemint.com/Politics/5k07wKxfIQE6vMaDmi1ewM/Five-charts-that-show-how-women-suffer-the-most-from-water-s.html]

Hinders the Growth of Businesswomen

As a result of this water crisis, women spend nearly six hours everyday in the process of bringing water to their entire household. This can have an adverse effect on the development of an economy. This is so because women who have the aspirations of becoming an earning member of the family through business may not succeed as their workload is intensified by the additional task of gathering water from long distances.

Suggestions for Improvements

The government can ensure an easier accessibility to water in villages as in cities by implementing the following measures.

1. Fixing a proportionate supply of water to villages and cities based on their population so that the surplus water may not be exploited by the urban users.
2. Ensuring that the water supplied are pure for consumption and are not contaminated.
3. Implanting adequate water taps in the rural areas so that women are free from the water crisis.

Water Savers

Women can often prove to be the best savers of water. This is mainly because they are the ones who experience the real scarcity of water in the world by striving each and every day for it. The menfolk in the family never know the real worth of water and spend it lavishly as they do not undergo the struggle. A good reference can be taken from the story 'A Thirst For Home' written by Christine Leronimo in which the little girl named Alemitu walks miles everyday to fetch water. In such a situation they never try to consume this hard earned water so selfishly and keep it for their family's consumption and cooking purposes.

Conclusion

As pointed out by Shiv K Kumar in his poem 'INDIAN WOMEN', they sit patiently on the mouth of the village wells. The suffering of women continue even in this technologically developed generation. These developments are far from the reach of the rural section of the society. In judgement we may say that the governmental as well as the phallic support is required to help women reduce their burden and fulfil their aspirations of being a part of economic activities.

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IMPACT OF CLIMATE CHANGE ON WATER RESOURCES AND AGRICULTURE SECTOR IN INDIA

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Abstract

Climate change had a serious impact on the accessibility of different resources on the earth particularly water, which sustains life on this earth. Water was life, around seventy per cent of the earth's surface was covered in water. The global demand for water in agriculture increase by about 20 per cent by 2050. Increasing population and existing climate change scenario was posing a major challenge to the global fresh water resource. This challenge was more visible in agriculture sector, especially of water stressed countries, as it was often the biggest user of fresh water supplies. The study aimed to find out the climate change on agriculture sector in India and to analyze the agriculture production and irrigation in India. The entire study was based on secondary data from different published sources from government and other agencies. The regression analysis showed the positive relationship between agriculture production and irrigation and it is statistically significant. We conclude the study India was facing a decrease in available water resources that had implications on India's agriculture sector. Several regions in the country were experiencing water stress. Moreover, enforcement of best practices could help present policy makers and planners to enhance governance structures to further understand key indicators that could assist in data driven decision-making.

Keywords: *Climate change, Water, Agriculture and Irrigation.*

Introduction

Climate change had a serious impact on the accessibility of different resources on the earth particularly water, which sustains life on this earth. Changes in the biosphere, biodiversity and natural resources were harmfully affecting human health and quality of life. However, there would not be uniform across different River Basins (RB) and Agro Ecological Zones (AEZs) of the country. In particular, in warmer and dryer AEZs, climate change might increase demand for irrigation as an adoption strategy to higher temperature and volatile weather condition (Taheripour, et.al, 2015). On the other hand, in some AEZs, climate change might positively affect rain fed crop yields and hence reduce demand for irrigation and weaken intensity of water scarcity. Hence, while irrigation adoption was commonly suggested as an important alternative response to climate change, changes in water scarcity could differentially affect both the supply of water and the demand for additional irrigation in agriculture across AEZs in India.

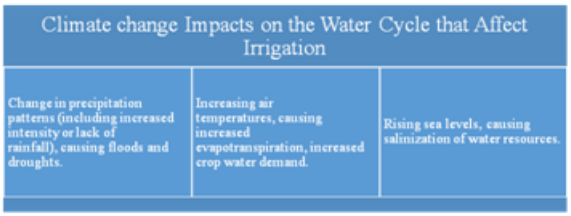
The global demand for water in agriculture increase by about 20 per cent by 2050. Water was together with soil, the most important input for agriculture. Only if agriculture had sufficient clean water it could fulfill its role as a major supplier of food and ensure food supplies for the growing world population (Global Form for Food and Agriculture, 2017). It was frequently known that the economy of India and in particular its agricultural sectors would face serious water challenges over the coming decades. Population growth coupled with economic growth of nearly seven per cent per year to 2030 would translate into strong growth in food demand and hence crop production in India. Given that roughly 60 per cent of crops produced in India were irrigated this would likely require a major expansion in demand for water. Growing demand for irrigation, when coupled with increases in industrial, residential and commercial demands for water, was projected to result in intense competition for water in India.

Water was life, around seventy per cent of the earth's surface was covered in water. However, only about one per cent of this water was freely available as freshwater and able to be used by mankind. Over the last fifty years, water utilization had almost tripled. Increasing water insufficiency was being accompanied in affected regions by better competition over water usage, which in turn was also putting supporting stability and economic and social development at risk. The sustainable use of water as a vital resource was one of the major global challenges of

the 21st century. Around seventy percent of the freshwater used worldwide for the agricultural production.

Impact of Climate Change on Irrigation

Climate proofing attempting to minimize the possibility of climate change undermining the value and sustainability of agricultural productivity intervention was key in ensuring that suitable climate change responses were included in investment plans for water management in agriculture sectors.



Source: FAO, (2017)

Statement of the Problem

Increasing population and existing climate change scenario was posing a major challenge to the global fresh water resource. This challenge was more visible in agriculture sector, especially of water stressed countries, as it was biggest user of fresh water supplies. India was a classic case of this unfolding scenario. India was already categorized as water stressed country in terms of per capita freshwater availability (1544 cubic meter in 2011). Out of the 4 per cent share of global freshwater availability in India, almost 78 per cent share of water was consumed by the agriculture sector Sharma et.al.,(2018). UN Population projections of 2017 showed that India would be most populous country on this planet surpassing China by 2024. Most of the studies by OECD, IMF, etc also show that India was likely to register a population growth of about 7 to 8 percent for the coming decade or so. By 2030, India was also likely to have 600 million people living in urban areas, up from current level of about 380 million. The pressure on water, both for producing more food, feed and fiber as well as for rising urbanization and industrial activity, would be tremendous. The global water risk hotspots, India's north-western region had already been identified as one among the three top most water risk hotspots in agricultural production, the others being north eastern China and south western USA. Against this background, ensuring optimum water productivity becomes essential to ensure sustainable growth in agriculture. It might be worth noting that water was likely to be a more binding constraint to Indian agriculture than even land, and therefore it was time to change the mind-set from raising agricultural productivity per unit of land to per unit of water.

Need for the Study

Irrigation of water management for sustainable agricultural development efficient water management should be addressed timely. Irrigation, which was artificial application of water to crop might improve the yield of crops many folds, if it was applied adequately, in equitable manner and at appropriate time. Water was not available for irrigating crops in required amount, sometimes it was in deficit or it was in excess. If it was available then accessibility and affordability were also issues of importance, which should attention of planners and policy makers. Currently, water management experts try to explain yields with respect to water by using the term 'Water Productivity', which was expressed as yields per unit of water. Water productivity could be improved by two ways only to increase yield without increasing water consumption or sustain yield and reduce water consumption. To attain this, it was required to apply recent and efficient on farm water management technologies in farmers' fields keeping in view the farmers' socioeconomic conditions, and other prevailing constraints If water saving technologies was applied in farmers' fields more area could be irrigated with limited water. These water saving technologies include reducing the various losses in conveyance, application, distribution, storage and utilization processes.

Background of the Study

(FAO, 2012) examined the new projections, as updated historical data from the Food Balance from 1961-2007, undernourishment estimated from The State of Food Insecurity in the World were used in the projections and new GDP data and projections from the World Bank. The study estimated of land under forest and in protected areas from the GAEZ were taken into account and excluded from the estimates of land areas suitable for crop production in agriculture. **Kumar and Gautam (2014)** focused on climate change and agriculture in India. Climate change has a serious impact on the availability of various resources on the earth especially water, which sustains life on this planet. Climate models predict a gradual rise in carbon dioxide concentration and temperature across the globe. **Taheripour (2015)** examined the consequences of climate change for India's agricultural, water scarcity could affect the irrigation adoption and demand for water and

how water scarcity, climate change, and trade jointly alter land use changes across the Indian subcontinent. However, water scarcity, induced by expansion in water demand in non-agricultural uses and lack of water infrastructure, blocks the demand for irrigation and that generates significant negative impacts on the economy of India and its agricultural activates.

Methodology

Climate change had a serious impact on the accessibility of different resources on the earth particularly water, which sustains life on this earth. Changes in the biosphere, biodiversity and natural resources were harmfully affecting human health and quality of life. Agriculture would also be impacted due to climate changes imposed on water resources. India would also begin to experience additional seasonal variation in temperature with more warming in the winters than summers. Climate change was affect a great risk to agriculture and food security. In this context the study is based on Secondary data was collected through various secondary sources namely Agriculture Statistical at Glance (2016), and Various Government Reports (2016-17) Indian Meteorological Report, (2015) etc., The study was used appropriate statistical tools of regression analysis. The specific objectives of the study were to find out the climate change on agriculture sector in India and to analyze the agriculture production and irrigation in India.

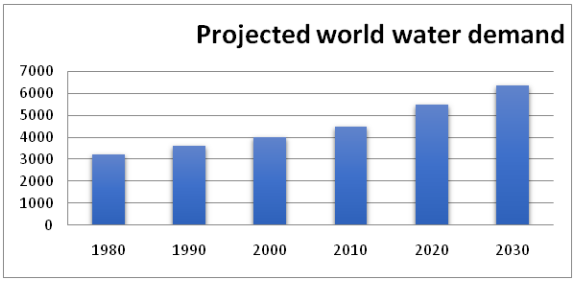
Limitations of the Study

- It is a macro level study. The Findings of the study may not be applicable to the micro level.
- The study has used the year 2016-17 data on Agriculture Statistical at Glance from Government of India. If monthly or annually data have been available the results might have been different.

Major Findings of the Study

Demand for Water in Agriculture in World Level

Improvements in crop water productivity can result in commensurately large decreases in water use because agriculture accounts for the largest quantity of water use. With water use efficiency ranging between 10 per cent and 30 per cent for rain fed and between 40 per cent and 95 per cent for irrigated agriculture, there was nearly always opportunity for improvement. As water demands increase in the developing world, irrigation reliability was expect to decline from 0.79 (out of 1.0) in 2005 to 0.71 in 2025. In areas where groundwater use was unsustainable, improving efficiency allows production to continue longer into the future. The use of technology to inform irrigation scheduling could save water, and also increase crop yields compared to over-irrigation (Tess Rutto et.al.,2014). Crop water production could be further improved by combining irrigation scheduling with farm management techniques including mulching, reducing soil hydrophobicity and the use of wastewater .



Source: World Statistics Portal, 2018.

Figure 1 Projected world water demand from 1980 To 2030 (in cubic kilometers)

This statistic represents the projected annual water demand worldwide between 1980 and 2030. In 2020, the global demand for water was estimated to be around 5.5 cubic kilometers. According to the source, agriculture water productivity is estimated to increase at 0.8 percent per annum, and industrial water use at around 0.5 percent a year.

Demand for Water in Agriculture In India

India was not a water wealthy country and promote challenged due to negative impact of climate change, enormous wastage owing partly to poor management and distorted water pricing policies. India received an average of 4,000 billion cubic meters of precipitation every year. However, only 48 per cent of it was used in India's surface and groundwater bodies. A dearth of storage procedure, lack of adequate infrastructure, inappropriate water management has created a situation where only 18 to 20 per cent of the water was actually used. India's annual rainfall was around 1183 mm, out of which 75 per cent was received in a short span of four months during monsoon. This result in run offs during monsoon and calls for irrigation investments for rest of the year. The population of India was likely to be 1.6 billion by 2050, resulting in increased demand for water, food and energy. This calls for infrastructure expansion and improved resource utilization (Vibha Dhawan, 2017). It was worth mentioning that climate change would had negative impact on

agricultural productivity ranging from crop selection; time of cultivation, irrigation methods etc.,.

Sources of Irrigation

Irrigation consumes about 84 per cent of total available water. Industrial and domestic sectors consume about 12 and 4 per cent of total available water, respectively. With irrigation predicted to remain the dominant user of water, "per drop more crop" is an imperative. Irrigation infrastructure in India has seen substantial expansion over the years. While proving to be a valuable source of irrigation expansion, injudicious utilization of groundwater through the explosion of tube wells had raised several sustainability issues. The various sources of irrigation in India for the years 2010-11 were listed in Table-1.

Table 1 Different sources of irrigation in india

Year	Canals	Tanks	Wells	Other Sources	Total
1950-51	8295	3613	5978	2967	20853
1960-61	10370	4561	7290	2440	24661
1970-71	12838	4112	11887	2266	31103
1980-81	15292	3182	17695	2551	38720
1990-91	17453	2944	24694	2932	48023
2000-01	15965	2455	33828	2885	55133
2010-11	17006	2249	30258	4289	64625

Source: Directorate of Economics and Statistics, Ministry of Agriculture (2012).

Government had given considerable importance to the development of command area under canals. Earlier during 1950-1951, the canal irrigated area was 8.3 million ha which was now 17 million hectares. Despite that, the relative importance of canals had come down from 40 per cent in 1951 to 26 per cent in 2010-11. Wells and tube wells accounted for 29 per cent total irrigated area in 1951 and they had a share of 64 per cent of the total irrigated area in 2010-11.

Irrigation in India

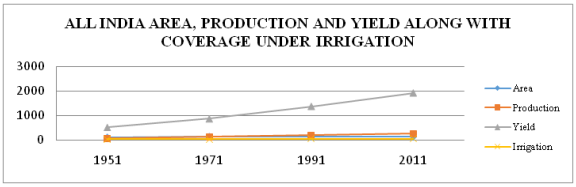
Since India was a country with an important agricultural sector and over 55 per cent of population was dependent on agriculture, many state governments were offering incentives to ensure availability of water for irrigation purposes. Rough mountains, sandy deserts and rocky terrains deep aquifers from which extracting water becomes an expensive proposition tend to had very poor irrigation facilities. Fertile alluvial plains with perennial rivers and potable groundwater as well as areas of less than 125 cm of annual precipitation were by far, the areas of high percentage of irrigation. The highest intensity of irrigation exists in the Kashmir Valley, large parts of the states of Punjab (Northern India) and Haryana, the Ganga-Yamuna Doab of the state of Uttar Pradesh (Northern India), Western part of the South Bihar (Eastern India) Plain, Birbhum, West Bengal (Eastern India), Lakhimpur, Assam (Northeastern, the Godavari Krishna Deltas and Chengalpattu district), Tamil Nadu (Southern India). The areas of low intensity were those which either do not need irrigation by virtue of high and dependable precipitation or had not been able to develop irrigation facilities due to unfavorable geographical conditions such as rugged topography, lack of surface and ground water, among others. The area, production and yield in food grain in 2013-14 and the proportion of area under food grains irrigated in 1951 to 2011 were enlisted in Table-2.

All India area, production and yield along with coverage under irrigation

Area in Million Hectares

Production in Million Tonnes

Yield in Kg Hectares



Source: Directorate of Economics and Statistics, Agriculture Statistical at Glance, 2016.

Figure 2

As its clear from the above table- there is increase in production during 1951 it is 50.82 million tonnes which rose to 244.29 million tonnes in 2011. The area under irrigation in 1951 it is 18.1 per cent and it was increased to 47.8 in 2011. Total food production of food grains increased from 51 million tonnes in 1951 to 244 million tonnes in 2011. The country's requirement for food grains in order to provide for its population is projected to be 300 million tonnes by 2025 (Second Advanced Estimates of production of Food Grains, 2016-17). Despite high levels of production, agricultural yield in India was lower than other large producing countries. Agricultural yield was the quantity of a crop produced on one unit of land. Agricultural yield of food grains had increased by more than four times since1950-51 and was 1930 kg per hectare in 2014-15. Hence India Yield was low when compared to other countries such as China, Brazil and the USA.

Regression Analysis of Area, Production, Yield and Irrigation in India

Regression analysis was used to understand which among the independent variable were related to the dependent variable and to investigate the forms of these relationships. In restrictors conditions, regression analysis could be used to infer relationship between the independent and dependent variables. Regression analysis was carried out in order to identify the agriculture area, production, yield and irrigation by using secondary data for the period from 1950-51 to 2010-11, the results of the analysis are obtained in Table 2.

Table 2 Regression analysis of area, production, yield and irrigation in india

Particulars	Beta Value	Standard error	t-value	Significant
Irrigation	-.385	26.422	-.015	**.004***
Area	.035	.218	.158	**.005***
Production	-.159	.334	-.474	**.003***
Yield	.043	.042	1.033	**.007**
R^2 Value	.987			
F-Value	74.652			
Significant	**.003***			

Source: Agriculture Statistical at Glance, 2016.
Note: *statistically significant at 1 per cent level.

The result of the regression analysis was shown above Table-2 the independent variable as irrigation (1951-2011) at India level. The regression analysis had done to find out the irrigation availability on area, production and yield. The value of R^2 value was .987 which implies that the 98 per cent of variation and it is statistically significant at 1 per cent level and the F- Value was also significant as 74.652.

Conclusions

Presently, India was facing a decrease in available water resources that has implications on India's agriculture sector. Several regions in the country are experiencing water stress. If water use efficiency does not improve, the country could suffer under water scarcity in the next 1 to 2 decades. It is exceedingly important that the agriculture sector contributes to prevent the exacerbation of the situation by making best use of the available technologies and resources to increase water use efficiency. Improvement of policies, strategies and regulatory measures to prevent the water misuse should be taken into consideration. Awareness and orientation of water users in the agriculture sector to switch to more water efficient production methods can help the country against water scarcity. Moreover, enforcement of best practices can help present policy makers and planners to enhance governance structures to further understand key indicators that can assist in data-driven decision-making.

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RAIN WATER HARVESTING

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Abstract

Water is one of the most important substances on earth. All plants and animals must have water to survive. It plays an important role in an economy. Rainwater harvesting is the storage of rainwater for reuse on-site, rather than allowing it to run off. It is considered as a very reliable way to conserve water. The most common method of rainwater harvesting is roof top harvesting. Harvested rainwater can also be used for gardens, livestock, irrigation, etc. Tamil Nadu is the first Indian state to make rainwater harvesting mandatory. Ground water resources get naturally recharged through percolation. But due to indiscriminate development and rapid urbanization, exposed surface for soil has been reduced drastically with resultant reduction in percolation of rainwater, thereby depleting ground water resources. Rainwater harvesting is the process of augmenting the natural filtration of rainwater into the underground formation by some artificial methods. Hence, it is necessary to opt for rainwater harvesting measures for fulfillment of water requirement.

Keywords: *Rainwater, rooftop, storage, catchments, filter*

Introduction

Water is the "universal solvent "so, it is a key component ensures quality of lives. No creature can survive without the existence of water. Even though we are surrounded by huge water bodies, in India we are facing water scarcity because around 97% of total water on earth is salt water and fresh water on earth is only 3% which is found as glaciers, rivers, lakes, and underground water. According to recent study, around 25% of the urban population does not have access to fresh water, so it is our bound duty to deal with saving water by using various techniques such as rainwater harvesting, conduits, fist flushing etc…In India rainwater system act was first initiated by Tamil Nadu in 2001 which gave an excellent result within five years and later followed by Karnataka, Rajasthan and Maharashtra. In this context, paper will provide an overview about rainwater harvesting system, types, techniques and its schemes.

Objective

The study is to analyze the rain water harvesting and discuss its various methods.

Data Collected

The study is based on secondary data. It is collected from various journals and websites.

Rainwater Harvesting

Rainwater harvesting is a technique used for collecting rain water and use it for a varied purposes. The rainwater is collected from various hard surfaces such as rooftops, and other man made aboveground hard surfaces. The collected water can be used for garden, livestock, irrigation, domestic use with proper treatment; indoor heating for houses etc… and it is even used for drinking purposes, longer term storage and other purposes such as groundwater recharge. It is one of the simplest and oldest methods of self-supply of water. Thus water conservation can be easily practiced in individual houses, apartments, parks, office and temples too across the world. Farmers have recharged their dry bore wells, created water banks in drought areas, and greened their farms, increase sustainability of their water resources.

Rain Water Harvesting in Ancient Times

The capturing and storing of rain water goes back thousands of years to when we first started to farm the land and needed to find new ways of irrigating crops .In India water harvesting have been practiced since time immemorial .During the last about 100 years, the objectives and focus of water harvesting have undergone considerable change by basic technique. In Neolithic age the construction and use of cisterns to store water can be traced. By late of 4000 BC cisterns were important elements of emerging water harvesting techniques in dry land farming. Various rainwater harvesting techniques are:

- Paar system
- Talab
- Saza kuva
- Johad

- Pat
- Naada /Bandha

Types of Rainwater Harvesting

There are different types of rainwater harvesting systems but they all have one thing in common which to utilize our natural rainfall to a maximum extent. The government is also encouraging new builds to include rainwater harvesting system to store water .Following are the types of rainwater harvesting system.

Water Butt

This is an simplest form of rainwater harvesting found in many gardens. They are large plastic containers for collecting water from drain pipe. It is cost efficient and will last a long while.

Surface Runoff Harvesting

In this method water is accumulated in a small constructed area like pits, wells, trenches, shafts, etc., and infiltrated under the soil. This the indirect method of rainwater harvesting so there no direct gain but in long term this is the best method of harvesting water. This method of rainwater harvesting is also called as recharging ground water aquifer. It is constructed in such a place that maximum rainwater could be accumulated. There are different methods of surface runoff harvesting. Some of them are as follows;

- Recharging of bore holes
- Recharging through wells
- Recharging through pits
- Recharging through trenches
- Recharging through shafts
- Recharging through percolation tanks

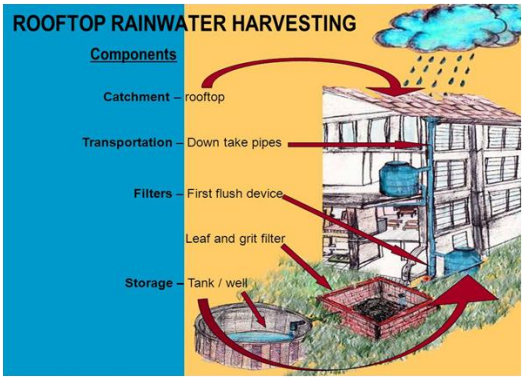
Rooftop Harvesting

Rooftop harvesting is a technique through which rainwater is collected from the roof catchments and stored in reservoirs. The objectives of rooftop rainwater harvesting is to water available for future use. This method is usually of good quality and does not require treatment t before consumption. Different catchments are used such as roof catchments, paved surface catchment, surface catchments and river catchments.

Components of Rooftop Harvesting System

The system mainly constitute of following sub components:

- Catchments
- Transportation
- First flush
- Filter



Catchmets

The surface that receives rainfall directly is the catchments. It may be terrace, courtyard, or paved or unpaved open ground. Therefore this area contributes rainwater to the harvesting system.

Transportation

Rainwater from rooftop should be carried through down take water pipes. These pipes should be UV resistance. Water from sloping roof should be caught through gutters and mouth of each drain should have wire mesh to restrict floating materials.

First Flush

It is a device used to flush off the water received in first shower. This process is done to avoid contaminants of atmosphere and the catchments roofs. It is also helpful in cleaning of slit and other materials deposited on the roof during the dry seasons.

Filtration

Filters are used effectively to remove turbidity, color and microorganism. The different types of filters

- Sand gravel filters
- Charcoal filters
- PVC-Pipe filters
- Sponge filter

Legislation on Rainwater Harvesting in Tamil Nadu

The rainwater harvesting system scheme, was launched in 2001 in bit to rejuvenate water resources an improve ground water level. The government of Tamil Nadu has made rainwater harvesting mandatory for all the buildings both public and private, in state .This scheme has helped people in water-starved regions by rising water tables. This scheme has been implemented in rural pockets too, the greater degree of success. This scheme is mandatory for Chennai metropolitan development authority to sanction building plans only after implementation of rainwater harvesting. Chennai Municipal Corporation has implemented rain water harvesting at 29 flyovers, 242 structures in openarea, 945 road margins and temple ponds.

Importance of Rainwatwer Harvesting

Rainwater harvesting can also satisfy the ever rising need of water and quantity of water in subterranean can be increased. Rainwater can be gathered and can be used for agricultural, commercial, domestic purposes. The requirement of water for feeding the livestock can be met. It helps in rejuvenating the groundwater levels in both directly and indirectly manner. The water contains almost neutral ph. and zero hardness which makes it more able to be used in homes, industries, institutions and other commercial establishments. It is helps in controlling urban flooding if people harvest from rooftops.

Conclusion

The drop of rain water is a blessing of God to the people on the earth, fresh rain water falls on the ground like pearls, so everyone should understand the importance of rain water especially in developing regions and rural areas which is lack of natural water resources. We must always try to collect the rain water without wasting through rooftops and along streets run off. We should bring our old traditional harvesting practices using new and effective technologies to make easy water supply in all the regions.

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RIVER SIRUVANI OVER THE YEARS – A CASE STUDY

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Abstract

Scholars since ancient time believe that the universe is made with the composition of five elements. All these five elements are present in the balanced state in this universe. For instance: if the level of water increases upto a certain limit, then the whole world will be filled with water resulting in floods. These five elements, water, air, fire, space and earth are together known as "Panchtatva .Jupiter is the lord of the element, "Space". Siruvani Waterfalls and the dam named after them are located 35 km (22 mi) west of Coimbatore in the Western Ghats. The reservoir at Siruvani was built for Tamil Nadu by the Kerala government with funds collected by the Tamil Nadu government to meet the drinking water requirements of Coimbatore. The gateways on either side of the road across the dam are typical of the Kerala and Tamil architectural styles. Siruvani is also home to certain tribals like the Mudugars and Irulars. Environmentalists and social workers blame massive deforestation and large-scale illegal sand-mining for the present plight of the east-flowing inter-State river, which emerges as the second largest river of Tamil Nadu after crossing the border so its our duty to preserve siruvani for the future generate

Introduction

"Human nature is like water. It takes the shape of its container."

— Wallace Stevens

Scholars since ancient time believe that the universe is made with the composition of five elements. All these five elements are present in the balanced state in this universe. For instance: if the level of water increases upto a certain limit, then the whole world will be filled with water resulting in floods. These five elements, water, air, fire, space and earth are together known as "Panchtatva.

Five elements of Nature

Jupiter is the lord of the element, "Space". Space is the only element which doesn't not have any limit. Prithvi or earth is the karak element of space. Hope and enthusiasm come under the jurisdiction of space. Scholars have categorized the qualities of" Air "in two parts - Word and Touch. The senses of touch is related to skin of a body and air is the base of it. lord Vishnu is the ruling deity of Air. The action of "Fire" comes under the purview of life. As a matter of fact, Sun is source of fire that gives light on earth. In the absence of Sun, there will be no light on earth. The shadow of darkness will cover the entire earth leading to destruction of life. The fire persisting from the Sun gives energy to other planets as well. Mercury is the lord of "earth". Fragrances or smell is the karak element of earth. The action of Fire comes under the purview of bones and skin. As per the scholars, earth is a huge magnetic land. Moon and Venus both are considered to be a "water" element and thus govern water. It is the karaka of juice or nectar. Since water and blood both are in liquid form, this element come under the purview of blood. Scholars have categorized water into four parts - word, touch, appearance and juice. Here the word "Juice", signifies taste. All the things that are found in liquid form on earth are categorized under the heading of water. Water is another essential factor to survive. Water is also used to generate electricity on earth. Lord Indra and Lord brahma are considered to be the ruling deity of water element.

River of India

As the rivers of the north India have their sources in the Himalayas, they are perennial, being snow-fed in summer. The major rivers are the Ganga and its tributaries, the Brahmaputra and the Sutlej, Ravi and Beas - the main tributaries of the Indus. The major rivers of south India are the Narmada, the Tapti, the Mahanadi, the Godavari, the Krishna, "the Cauvery" etc. These rivers have their sources in different mountain ranges of the south India and hence they are not perennial - they dry up in summer

Siruvani

The Siruvani River is a river near Coimbatore, India. It is tributary of Bhavani river,[1] which in turn is a tributary of Kaveri. Part of the Siruvani River is near Mannarkkad in the Indian District of Palakkad, Kerala. The river leads into

two big tourist attractions in Southern India, namely, the Siruvani Dam and the Siruvani Waterfalls attappadi is an extensive mountain valley at the headwaters of the Bhavani River nestled below the Nilgiri Hills of the Western Ghats. It is bordered to the east by the Coimbatore district in Tamil Nadu, on the north by the Nilgiris, south by the Palghat taluk. Gneisses are the predominant rocks found here. Also the presence of Gold in the Attappadi region has been confirmed by the Deccan Gold mines. In Attappadi region gold grains are found only in native state and occur in different shapes and sizes. Gold having its own wide range of medicinal properties is a sure contributor to the richness of Siruvani water.

Apart from the water it provides, the river is a major tourist attraction by itself. It is one of the most popular tourism zones of South India. The Siruvani waterfall Scientists say that the taste of water is due to the mineral content present in it. While many manufacturers of bottled water struggle to strike the perfect balance of minerals for the sake of the water's taste and nutrient content River Siruvani which flows near Coimbatore is a tributary of River Bhavani which in turn is a tributary of river Kaveri. The taste of Siruvani is said to be acquired from the vegetation and minerals found in the Attappadi valley.

Siruvani Waterfalls and the dam named after them are located 35 km (22 mi) west of Coimbatore in the Western Ghats. The reservoir at Siruvani was built for Tamil Nadu by the Kerala government with funds collected by the Tamil Nadu government to meet the drinking water requirements of Coimbatore. The gateways on either side of the road across the dam are typical of the Kerala and Tamil architectural styles. Siruvani is also home to certain tribals like the Mudugars and Irulars.

Siruvani Dam

The government gave its approval for construction of the `masonry gravity' dam in February 1915; work did not start immediately; if one correlates the information from the Archaeology Department, Tamil Nadu Water Supply and Drainage (TWAD) Board and the district gazette. The villagers of Boluvampatti and Alandurai opposed the scheme, as they feared it would affect them. But they were convinced about the benefits of bringing Siruvani water to a town that was growing. Construction began in 1927. The dam site was in an extremely unfriendly terrain and wild animals frequented the place. So, all those engaged in construction work stayed in the guest house near Iruttu pallam. They rode to the dam site on horses with gunmen providing security. The area below the Siruvani, Muthikulam falls, Gobiyaru, Solaiyaru, Pattiyaru, Veeraru and Paambaru falls, the main sources of supply, was identified for construction The present position puts the drinking water supply at a comfortable position for the city till May 2019. The reservoir meets the water requirement of around 25 wards in full and another 10 wards in part. To meet the requirements of the rest of the 100 wards, the Corporation uses water from the Pilloor Reservoir, River Bhavani, and River Aliyar. Sources in the Corporation say that with the reservoir filling up, the civic body will look at restoring alternate day supply of drinking water. In turn, the supply to the Pilloor water-fed areas could also be increased. Water in the Siruvani Reservoir usually overflows twice a year – in June/July, if the South West Monsoon is good and around November-December, if the North East Monsoon is good. So, if the first monsoon failed, the other used to compensate for it. But the past few years have been so bad that not only did the water not overflow, but the level in the Siruvani Reservoir dipped below the dead storage level

Significance of Siruvani in Coimbatore

One hundred and ten — that is the number of water taps that supplied the sweet Siruvani to the people of Coimbatore. It was on April 29, and the year was 1929. "In Race Course there were just six water connections," says C.R. Elangovan. He has recorded the history of Coimbatore in eight books including Coimbatore Varalaru, Siruvani and Kovaiyum Cinemavum. People offered flowers and worshipped the tap. It was the lifeline of Coimbatore, he says. It took 40 years for the project to see light. And, it was the entrepreneurial spirit of the visionary C.S. Rathinasabapathy Mudaliar that made it happen. Rathinasabapathy Mudaliar took charge as a member of the Municipal Corporation as a councillor and then became the chairman. "He gave a new lease of life to the proposed government project of generating hydel power from Siruvani and also meets the drinking water requirements of the city.The first document available on Siruvani scheme is from a lecture by S.P.Narasimmalu Naidu on August 25, 1889 about his visit to Siruvani Hills and Muthikulam Falls. In 1889, he submitted a proposal to bring the water downwards from Muthikulam Falls to River Noyyal. "A representative of the Indian National Congress, Narasimmalu Naidu was also a journalist, orator and landlord. A multi-faceted personality, he was keen to do public service. In the course of his treks in the Velliangiri Hills, he had observed that the Muthikulam Falls had abundant water all through the year. He made several trips

there. It did not deter him that elephants and tigers roamed freely in the forest. After heavy rains, there was the danger of malaria. And it was leech infested. But he battled it all and conducted a survey," says Elangovan He submitted the proposal to the collector. It was to connect Muthikulam Falls, a perennial source of water with Noyyal to meet the drinking water requirements of the city. They put the project on hold due to lack of funds. Five other drinking projects, using water from River Noyyal bed above Vellalur Anaicut (1893), Chithirai Chavadi canal scheme (1900), Muthannan Kulam (1901), new reservoir below Krishnampathy kulam(1908) and from Sanganur stream and Singanallur tank, turned out to be failures. "There was neither electricity nor any vehicular connectivity from Noyyal to get the water to the city. And, people continued to suffer," he recounts. It was Rathinasabapathy Mudaliar's charisma and his influence in Madras that helped kick-start the project in 1920. "He visited Siruvani hills with the official survey team. The Revised Siruvani scheme was a package of drinking water and hydel power projects. They started the construction of a check dam at Siruvani to collect the water and bring the major portion of water down through a tunnel. Skilled labourers were brought in from Kolar Gold Mines of Karnataka. Though everything went smoothly, heavy rains played havoc. It led to heavy landslides and the entire structure crumbled. But, Rathinasabapathy Mudaliar didn't give up. After a quick recovery work, the water was brought to the town on April 26, 1929. And, Coimbatore boomed. The sweetness of the water is attributed to the green atmosphere, and the balanced mineral content. "For most part, it travels without any interference from human habitation. So there is no pollution. When Rathinasabapathy Mudaliar died, people placed Siruvani water at his feet and prayed."

Conclusion

Responsibility of younger generation

River systems are the world's ultimate commons. Their waters, which are essential to all life, provide food, water for drinking and bathing, transportation, irrigation, and hydropower. They also have been used throughout human history to carry off our waste, transporting our household, agricultural, and industrial effluents downstream. If we do not overload them, streams and rivers are capable of processing the pollutants we discharge into them while continuing to provide food, clean water, and habitat for wildlife Environmentalists and social workers blame massive deforestation and large-scale illegal sand-mining for the present plight of the east-flowing inter-State river, which emerges as the second largest river of Tamil Nadu after crossing the border. So its our duty to preserve Siruvani for the future generation

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