



Journal of Innovation for Inclusive Development

Volume: 2, Issue: 1

February 2017

URL: <http://jiiid.in>

ISSN: 2456-4478

Centre for Earth Studies
Indraprastha College for Women
University of Delhi



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ISSN : 2456-4478



Published from:

Centre for Earth Studies

Room No. 205, New Academic Block
Indraprastha College for Women
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Education for Sustainable Development: Need of the Hour

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The importance of Education for ensuring equity, equality and an egalitarian society cannot be overemphasized. Nelson Mandela, the late South African President and Nobel Peace Prize winner had declared Education as the most powerful weapon which can be used to change the world. Years later, Pakistan born Malala Yousafzai, also a Nobel Peace Prize winner echoed the sentiments of Nelson Mandela and stated, “One child, one teacher, one book, one pen can change the world.” The importance of Education can also be understood by the fact that the United Nations has included the Right to Education in its Universal Declaration of Human Rights document (UN, 1948). Prior to this, Mahatma Gandhi, the strongest symbol of peace and non-violence, though never awarded with the Nobel Peace Prize, also highlighted the importance of Education for growth and prosperity. A sustainable development pioneer himself, Mahatma Gandhi believed that true education must correspond to the surrounding circumstances or it will not lead to healthy growth.

From the above it is clear that Education is indeed the solution to all problems, be it social, economic or environmental. Interestingly, the latter are also the three cornerstones on which the concept of sustainable development rests. The three main pillars of sustainable development are social equality, economic growth and environmental protection. Sustainable development can be achieved by creating a balance between these three factors. Thus, Education is an essential pre-requisite for ensuring sustainability and Education for Sustainable Development is the need of the hour. Fortunately, the United Nations realizes this well so much so that the 2005-2015 decade was declared as the UN Decade of Education for Sustainable Development (DESD). The vision behind DESD was mainly to emphasize to the

world and to world leaders that education is an indispensable element for achieving sustainable development. The post-DESD Report lauds the initiative for bringing increased recognition at the international policy level that education is essential to the advancement of sustainable development (UNESCO, 2014). However, there is enough literature to show that post-DESD, at the end it was business as usual (Huckle and Wals, 2015). It is perhaps this reason why Quality Education has been listed as the one among the 17 Sustainable Development Goals which needs to be achieved between 2016 and 2030 (Singh, 2016).

Education for Sustainable Development may be interpreted in two very different ways. First, it implies that all individuals, from all sections of the society, - irrespective of their caste, class, gender - are provided with basic and quality education. Providing quality education to all citizens would mean creating a thoughtful, responsible society which would then be careful about its present and future. Large number of educated citizens would mean greater protection and preservation of environment and judicious use of natural resources. It is also hoped that Quality Education will accompany better livelihood opportunities for all resulting in an increase in the average per capita income of respective nation states. This may further help respective nation states by pushing them down the Environmental Kuznets curve on the right side of the graph (Stern et al., 1996).

The second inference of Education for Sustainable Development focuses more on the transformative role education needs to play for achieving sustainable development. This also includes the promotion of transformative learning and research at all levels of education. This may require developing of learning resource materials, creating innovative pedagogy, - introducing research based teaching and taking the class

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out of the classroom. An important point that needs to be kept in mind here is that Education for Sustainable Development must not be seen as similar to Environmental Education. Indeed that has been the case more often than not and is perhaps the reason why the entire burden of ensuring sustainable development has fallen only on the subject of Environmental Studies. The Environmental Education sector may at best spearhead the shift to Education for Sustainable Development. It has, in fact, already taken the lead. What needs to be reiterated is that it should not be isolated by the two other pillars of sustainability, viz. economic growth and social equality.

Much needs to be done today for augmenting the existing education system to accommodate the teaching of the principles of sustainable development. While on the one hand, existing syllabi have to be retrofitted; on the other, new literature and study material needs to be prepared at all levels of education. Since sustainable development is an emerging and dynamic field, its educators will have to make consistent efforts for keeping themselves and their teaching materials updated. Education for Sustainable Development would also mean policy level changes in terms of what to teach and how to teach, which may require considerable consultation and advocacy. Targeted strategies will need to be formulated to ensure adoption and implementation of Education for Sustainable Development lessons at all levels of education, right from primary to higher education. While at the school level, sustainable development lessons may be amalgamated with existing and ongoing teaching, higher education institutions may consider designing courses for teaching sustainability.

Irrespective of the interpretation or the method followed, what is important is that centres of all learning adopt and shift to Education for Sustainable Development as soon as possible. It is only in making this shift that the world can achieve the Education for Sustainable Development milestone, as envisioned by UNESCO. That is, creating a world where everyone has the opportunity to benefit from quality education and learn the values, behaviour and lifestyles required for a sustainable future and for positive societal transformation. The Journal of Innovation for Inclusive Development (JIID) remains dedicated towards furthering our understanding for achieving the 17 Sustainable Development Goals, of which Quality Education is one.

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Status and Evolution of Environmental Education at School Level in Delhi, India

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Abstract: The need for imparting environmental education in school students has been well understood in Delhi, India and efforts have been made to incorporate environmental education (EE) in the curriculum. At the same time, increasing interest in the protection and conservation of environment, nature and natural resources has led to the initiation and adoption of several campaigns, programmes and projects by various schools. Consequently, the integration of EE in the curriculum as well as through extra-curricular activities is exposing the school students to contemporary environmental challenges and their solutions. This research work is an attempt at exploring the various measures being taken to promote environmental awareness and create better attitude towards the environment in the schools in Delhi, India.

Keywords: environmental education, school level, education policy, India.

1. Introduction

Environment is an essential entity of life in the sense that the survival of life depends on it in one way or the other. However, man and his activities have led to the present deteriorating condition of the environment. There is an increasing need to ameliorate the situation which makes it extremely essential to promote Environmental Education as a tool for life and learning right from childhood. Environmental Education (EE) can be defined as the process of recognising values and clarifying concepts in order to develop skills and attitude necessary to understand and appreciate the inter-relatedness among humans, their culture and their bio-physical surroundings (IUCN, 1970). It is a process of developing a world population that is aware of and is concerned about the total environment and its associated problems and which

has the knowledge, attitudes, commitments and skills to work individually and collectively towards ameliorating the current problems and preventing the creation of new ones.

Growing evidence of the nature and scale of global environmental change, which particularly is a result of technological growth and its application, is provoking concern in places across the world. Questions about global inequalities, the vulnerability of ecosystems and sustainability of existing lifestyles are at the forefront of national and international agendas. Hence, in order to create an environmentally aware population, well equipped with the most comprehensive knowledge and understanding of the environment and a will or attitude to make a difference, EE is being considered and promoted as an integral part of education and being incorporated in the structure, pedagogy and curriculum of academic institutions. This need for incorporating EE at the school level is even more important and therefore EE needs to begin from a primary level to generate sensitivity towards the environment in young minds.

2. Origin of Modern Environmental Education

Efforts to define and adopt environmental education as a specific endeavour began in 1960s and were given international support at the United Nations Conference on the Human Environment (UNCHE) held in Stockholm in 1972. At the Stockholm Conference, participating governments recommended that EE be recognized and promoted on an international scale through the United Nations. One of the initial tasks undertaken as part of the Stockholm Conference was to develop a consensus on what environmental education could and should become, and to assist governments in implementing relevant programmes as soon as practicable. Subsequent to the Stockholm Conference, two major conferences, supported by regional meetings of experts, were hosted by the then newly formed UNESCO-UNEP International

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Environmental Education Programme. The purpose of the first conference was to draft concepts and a vision for environmental education (in Belgrade in 1975). The second conference, an Intergovernmental Conference on Environmental Education, formally approved the scope and action plans put forward from the previous conference (in Tbilisi in 1977). The second conference concluded with the 'Tbilisi Declaration on the role, objectives and characteristics of environmental education'. The provisions of this Declaration remain in wide international use even today and have sustained their role as a guiding influence over the past two decades. Another major milestone with respect to promoting and adopting EE was the IUCN World Conservation Strategy (1980). The latter suggested requirements for human survival and prosperity, putting forward the conservationist concept of sustainable development.

Prior to the declaration of the IUCN World Conservation Strategy (1980), a UNESCO-Thessaloniki Declaration (1997) took place which was an umbrella document under the title, 'Educating for a Viable Future: a Multidisciplinary Vision for Concerted Action'. The UNESCO-Thessaloniki Declaration sought to further clarify the concept of Education for Sustainable Development. It presented sustainability as an ethical and moral imperative and the objective to which education should devote itself as an instrument of choice. It also declared that Education is described as an ongoing process aimed at developing the capability of adapting to rapid changes in the world, but first and foremost as a process of transmitting knowledge and information to make the public understand the problems and to stimulate awareness.

The United Nations Intergovernmental Conference on Environmental Education held at Tbilisi, Georgia, in the former USSR, in the year 1977 developed a series of fundamental concepts which EE organizations and institutions have accepted as their definition of EE. A single goal statement written in Belgrade, Yugoslavia in 1975 has been adopted as a widely accepted goal statement for EE according to the North American Association for Environmental Education (NAAEE, 1996; UNESCO, 1978; Athman and Monroe, 2000).

Environmental education is a process of developing a world population that is aware of and concerned about the total environment and its associated problems, and which has the knowledge, skills, attitudes, motivations and commitment to work individually and collectively toward solutions of current problems and the prevention of new ones. According to Gough (1997), the work done by

Harvey (1976) in synthesizing a definition from many professional papers, defines the term EE as: *the process of developing an environmentally literate, competent, and dedicated citizenry which actively strives to resolve values conflicts in the man-environment relationship, in a manner which is ecologically and humanistically sound, in order to reach the superordinate goal of a homeostasis between quality of life and quality of environment* (Gough, 1997).

This definition ultimately formed the basis for the declaration at Tbilisi and was the ultimate goal for curriculum development in EE proposed in the landmark publication Goals for curriculum development in environmental education (Hungerford et al., 1980). It is important here to mention the goals and objectives of EE recommended at the UNESCO-UNEP Tbilisi intergovernmental conference on EE. The goals are as following:

1. Goals of environmental education are:

- To foster clear awareness of, and concern about, economic, social, political and ecological interdependence in urban and rural areas;
- To provide every person with opportunities to acquire the knowledge, values, attitudes, commitment and skills needed to protect and improve the environment;
- To create new patterns of behaviour of individuals, groups and society as a whole towards the environment.

2. Categories of environmental education objectives are:

- Awareness: to help social groups and individuals acquire an awareness of and sensitivity to the total environment and its allied problems
- Knowledge: to help social groups and individuals gain a variety of experience in, and acquire a basic understanding of, the environment and its associated problems
- Attitude: to help social groups and individuals acquire a set of values and feelings of concern for the environment, and the motivation for actively participating in environmental improvement and protection
- Skills: to help social groups and individuals acquire the skills for identifying and solving environmental problems
- Participation: to provide social groups and individuals with an opportunity to be actively involved at all levels in working toward resolution of environmental problems (UNESCO, 1978).

Fishbein and Ajzen (1975) defined attitude as an evaluative mediating response, predisposing the individual to display various overt behaviour. Attitudes are formed and changed by the continuous process of having a concrete experience, making observations and reflecting on that experience, then forming abstract concepts and generalisations based on these reflections (Lewin, 1947).

Within the environmental education research there is a long tradition of addressing individuals' attitude towards the environment where, in general, students' environmental attitudes have been examined in regards to environmental knowledge, behaviour and socio-economic variables (Cavas et al., 2009; Hens et al., 2010; Kullmuss and Agyeman, 2002). Some examples of these approaches include: how to increase awareness in the class room (Chapman and Sharma, 2001; Madruga and da Silveira, 2003; Yilmaz et al., 2000) the association for positive environmental attitudes regarding personal environmentally responsible behaviour (Scott and Gough, 2003) and environmental sensitivity as an important issue of environmental awareness (Chawla, 1992; Chawla, 1999).

Madsen (1996) emphasized the concept that awareness is the ultimate driving force that stimulates knowledge. He emphasized the power behind the awareness factor by categorizing three levels of awareness as: basic belief of an environmental problem, factual and scientific knowledge, and a commitment to solve environmental problems. Awareness was studied along with environmental knowledge and concern by Hausbeck et al. (1992). In this study, the authors concluded that awareness and concern scores were significantly higher than knowledge levels in high school students. They linked this result with the fact that a primary source of environmental information is electronic media (NEETF, 1998), whereas awareness and concern can be picked up with little substantive knowledge.

Studies have also shown that environmental education must be implemented on a profound level in the pre-school and primary level of education wherein the prime objective should be to awaken the sensibility of the child to the environment (Caciuc, 2013). A study in North Bengal on the evaluation of EE in higher school education system has emphasized upon the importance of EE as a key to solve environmental problems and to maintain sustainability globally (Halder and Somenath, 2012). EE has a significant contribution to increasing awareness and knowledge and in shaping attitudes among students. A study on environmental knowledge, attitudes, consumer

behaviour and pro-environmental activities of Hungarian high school students, which explores the relationship strength between environmental education and knowledge and attitude, have shown a strong correlation between intensity of environmental education and environmental knowledge of students (Zsoka et al., 2012).

3. Environmental Education in India

In India, social values and attitudes have, historically and culturally been in harmony with the environment. One can find this in the classical literatures, the writings of sages, the religious texts, all of these reflect the recognition that all life forms on earth - human life include is intimately dependent on the quality of the environment as well as the need and responsibility to protect it.

The Constitution of India captured much of these deep-rooted values and further strengthened them by giving responsibility to its citizens to protect the environment. The constitution enjoins the "state to take measures to protect and improve the environment and to safeguard the forests and wildlife of the country" (Article 48-A) (Joshi, 1975). It also makes it a "Fundamental Duty of every citizen to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have ecological compassion for living creatures" (Article 51).

While India is fortunate in its sheer beauty, it is also replete with natural resource issues across the country. Ranging from a rapidly growing population and deforestation to soil erosion and water pollution, overall environmental degradation continues to worsen. Rapid industrialization and urbanization in India is booming, as the middle classes are also expanding. Urban communities are draining the limits of municipal services and causing severe air pollution problems. All this, and more, has placed significant pressure on India's infrastructure and natural resources contributing to ongoing efforts towards education and seeking overall pro-environmental behaviors (India Together, www.indiatogether.org/environment). The general rationale for providing environmental education programmes in India includes helping school children develop environmental awareness such that they grow up to be citizens who are conscious and sensitive to threats being faced by the environment (Dhavse, 2003).

India has always recognized the beneficial effects of environmentally-focused instructional programs as an essential part of education. According to Sarabhai et al. (2002), with over a billion people and at least 17 major languages, the diversity of India in terms of culture and

biological wealth is enormous. In spite of rapidly changing lifestyles, the traditions of living in harmony with nature and of environmentally sound practices underpin the lives of most people. It is against this backdrop that the country's environmental education strategy has evolved. India has always had a rich and inspiring history of environmental activism, the Chipko Movement (1970) being the most influential among them. In contrast, at the formal level however, schools, colleges and universities have only recently taken up environmental education. Teacher training with an environmental orientation began to emerge across India in the early 1990s, under the aegis of the Ministry of Human Resources Development.

The concept and substance of environmental education, as well as the need for revised curricula and teaching methodologies, was the subject of a study conducted by the Pune-based Bharati Vidyapeeth Institute for Environmental Education and Research (BVIEER) in 1999. The two-year long study led to observations on the efficacy of the then school environment education curricula at the state and national level. Another focus of the study was the issue of motivating students to care about environmental preservation. Once existing environmental concepts in school curricula were identified and major gaps found, a pilot study was launched with textbook revisions made in 800 schools in eight states, to ensure that the concept of the environment and its preservation were taught to students. BVIEER's recommended programme was subsequently implemented in 100 schools in Maharashtra, Goa, Andhra Pradesh, Assam, Jammu and Kashmir, Punjab, Orissa and Uttaranachal (now Uttarakhand). The situation has changed in recent times with the directive of the Supreme Court of India on the matter of implementing compulsory EE at the formal school education system.

3.1 EE and India's National Policy of Education

The concept of EE is now widely spreading in India as more emphasis is given on spreading the importance of an environmentally aware and sensitive young generation which is well equipped with the requisite knowledge and skills to cope with the ever-rising environmental concerns. Taking motivation from the Stockholm Summit 1972, India incorporated environmental concern in the Constitution through the 42nd Amendment in 1976. Environment has become a priority in policy statements, plans and strategies especially after 1980 with the establishment of a full-fledged Ministry of Environment and Forests (MoEF) (now renamed Ministry of Environment, Forest and Climate Change). Subsequently, the need for implementing EE in India has gained

consistent momentum and its importance was recognized by the Government and policy was planned subsequently to introduce EE in schools.

EE has always been a part of the school curriculum for several years. However, the present status of EE in school education system has had its genesis in the National Policy of Education (NPE) 1986 (modified in 1992), in which 'Protection of the Environment' is stated as a common core around which a National Curriculum Framework (NCF) has been woven. The national system of education, The NPE 1986, states that "Protection of the environment" is a value which, along with certain other values, must form an integral part of curriculum at all stages of education. Para 8.15 of the policy states: "There is a paramount need to create awareness of environmental concerns by integrating it in the educational process at all stages of education and for all sections of the society beginning with the child" (DoE-MHRD, 1998). According to the National Curriculum for Elementary and Secondary Education: A Framework (1988): "the school curriculum should highlight the measures for protection and care of the environment, prevention of pollution and conservation of energy". In consonance with these documents, Environmental Studies was introduced as a subject at the primary level. As per the National Curriculum Framework 2000, understanding the environment, both natural and social and their interactive processes, the problems as well as means and solutions to preserve the environment was one of the General Objectives of Education as per NCF 2000.

EE at primary and upper primary stages: At the primary stages, environmental concepts have been integrated into different subjects like Mathematics and Language courses. In the NCERT curriculum, the teaching of Language and Mathematics has been woven around the children's immediate environment in classes I–II and EE has been reinforced as a component of the Art of Healthy and Productive Living (AHPL). In classes III–V however, separate textbooks for environmental studies have been provided instead of separate subjects like Science and Social Studies.

EE at the secondary stage: The concept of EE has been prescribed in the textbooks through Science and the Social Sciences whether taught as integrated or separate subjects. NCERT textbooks of Science and Technology and Social Sciences include various concepts of EE. EE at higher secondary stage: A majority of concepts related to EE are found in the textbooks of Biology, Chemistry, Physics, Geography, Economics, Sociology and Political Science in the NCERT curriculum.

3.2 The NCERT Approach

Despite the initiatives mentioned above, there are several shortcomings in the proposed curriculum. The National Council of Educational Research and Training (NCERT) has, since then, gone ahead to create a new syllabi for EE which was later reviewed and revised in the light of the National Curriculum Framework of 2005. This was a result of a Public Interest Litigation (PIL) initiated by Shri M.C. Mehta and subsequent directive of the Supreme Court (SC). The latter was a big leap forward as it helped attract attention of the public to the importance of EE and helped in structuring the implementation of EE in formal education. On 18 December 2003, the SC directed the NCERT to prepare a module syllabus for enforcing compulsory education on environment for creating awareness. Further on 13 of July 2004, the SC directed that “the syllabus prepared by NCERT for classes I to XII shall be adopted by every state in their respective schools”. It further appointed NCERT as the nodal agency to supervise the implementation of the Court’s order.

In December 2010, the final pronouncements on the matter of the writ petition was given by the SC after NCERT filed an affidavit stating in detail, the approach which it had identified for implementing EE in the school education system. In the document submitted to the SC, the NCERT explained in detail the infusion approach, which meant that an environmental perspective was to be added to all subjects, from standards I to XII, compulsory evaluation of EE content with at least 10% of the total marks devoted to EE, no written exams for XII standard and major emphasis on project-based learning. NCERT clarified that in order to have compliance, a separate subject was not necessary. It further stated that infusion of EE would be done with subjects like Science, Social Science, Mathematics, Language and other subjects, and/or through a separate subject. Following the acceptance of the affidavit, NCERT published the ‘Handbook on Environmental Education’ which provides source material for the core course at the XI and XII standards. Project books were also been developed for standards VI to X.

3.3 Sequence of Events

A. Writ Petition, 1991: In 1991, Shri M C Mehta filed an application in the public interest (Writ Petition (Civil) No. 860 of 1991), requesting the Supreme Court to:

- Issue direction to cinema halls that they show slides with information on the environment;
- Issue direction for spread of information relating to the environment on All India Radio and
- Issue direction that the study of the environment becomes a compulsory subject in schools and

colleges. This consequent order of the Supreme Court was dated 22 Nov1991.

B. Directive to NCERT to Prepare EE Syllabus, 2003: On 18 December 2003, the Hon’ble Supreme Court ordered, “We also direct the NCERT...to prepare a module (model) syllabus and directed that “We accept on principle that through the medium of education awareness of the environment and its problems related to pollution should be taught as a compulsory subject. The University Grants Commission (UGC) will take appropriate steps immediately to give effect to what we have said, i.e. requiring the Universities to prescribe a course on environment. So far as education up to the college level is concerned, we would require every State Government and every Education Board connected with education up to the matriculation stage or even intermediate college to immediately take steps to enforce compulsory education on environment in a graded way”. Subsequent to that, the NCERT developed a graded syllabus for Environment Education for 1 to 12 standards, which was accepted by the SC (the syllabus has subsequently been revised for Standards XI and XII to incorporate contemporary environmental issues).

C. NCERT as Nodal Agency for EE, 2004

On 13 July 2004, the SC directed that “the syllabus prepared by the NCERT for Class I to XII shall be adopted by every state in their respective schools”. It further directed that “NCERT be appointed as a nodal agency to supervise the implementation of this Court’s order”. Compliance to Supreme Court order is mandatory and desirable, and applies to all states and Union Territories (in fact, it is one of the few things that apply to education uniformly all over India)

D. EE and the National Curriculum Framework, 2005

In 2004, MHRD set up a nationwide process towards the development of the National Curriculum Framework 2005. This included the setting-up of a national steering committee and 21 national focus groups. One of these was a Focus Group on Habitat and Learning. In substance and spirit, this group was to look into the area of EE. The group delineated the objective as, ‘The main focus of EE should be to expose students to the real-life world, natural and social, in which they live; to enable them to analyze, evaluate, and draw inferences about problems and concerns related to the environment; to add, where possible, to our understanding of environmental issues; and to promote positive environmental actions in order to facilitate the move towards sustainable development. The Group recommended a systematic infusion of components of EE into the curricula of all disciplines

while ensuring that adequate time is earmarked for pertinent activities. The NCERT prepared its new syllabi and textbooks in accordance with the NCF 2005.

E: NCERT Affidavit, 2007

The NCERT submitted an Affidavit in October 2007 to the Supreme Court describing the spirit of the NCF 2005 and clarifying that to have compliance with the earlier order of the Supreme Court, a separate subject for EE is not a necessity. It can be done through infusion, in Science, Social Studies, Mathematics, language and other subjects, and/ or through a separate subject. It does, however, have to be part of the compulsory curriculum. This Affidavit is a key document outlining the sequence of relevant events subsequent to the PIL up to the proposal for how EE may be transacted from Standards I and XII. It was drafted after detailed discussions between the petitioner (Shri MC Mehta), the respondent (NCERT), and the experts appointed by the petitioner and NCERT (Menon, 2013).

F. Acceptance of Affidavit, December 2010

The Affidavit was accepted by the SC on 3 December 2010 and the writ petition WPC 860/1991 has been disposed of. Now, all school education boards are expected to follow the approach to EE described in the Affidavit. NCERT is coordinating the effort to enhance implementation EE in the spirit of the NCF 2005 as it is the basis of the affidavit.

G. New Approach to EE Implementation - NCF 2005

Classes I and II – EE concerns are transacted through activities; Classes III to V – EE is being imparted through a subject namely EVS (Environmental Studies); Classes VI to X – Follows infusion approach for EE. 10 percent of assessment of grand total is based on EE besides project and field work in separate time carved out from existing timetable; Classes XI and XII – Besides infusion in electives, a separate compulsory course 50 marks based on core syllabus and projects work is for all. Marks to be reflected/ added to the total marks. Time to be carved out of existing time table (such as time allocated to General Studies).

It is important to note that the infusion approach has many advantages since EE draws from the different subjects of Science, Social Sciences, Geography, Mathematics, etc. However there are indeed a number of constraints in infusion as well, the main being the lack of opportunities for synthesis of the learning that may take place in different subjects. Another limitation is the absence of a common course at the higher secondary level into which EE content can be induced. To add to its existing

constraints, there also appears an urgent need to discuss the amount of time and space for EE along with the infusion approach.

There is a need to provide for a strengthening of this approach where content on Environment in different subjects can be dealt meaningfully thereby avoiding a dilution of focus. Instead of conducting unconnected project-based activities and routine teaching of a set of materials to be memorized in class, there is a need to shift the focus to a more meaningful approach, one which inspires a sense of awareness and sensitivity towards the environment in totality. Furthermore, exclusive time and space should be built in the school time table to translate the EE content into EE experience, using observations, project based activities and going out in nature; thus allowing learning beyond what textbooks have to offer. Moreover, measures also need to be developed to determine the effectiveness of infusion and projects, quality of teaching and learning. The strategy to succeed needs capacity building of the whole school through trainings and materials.

H. Expert Viewpoint:

This research contribution would like to bring forth some of the viewpoints of experts in the field of Education and Environment. Prof. Krishna Kumar, Former Director of NCERT is of the belief that a fresh approach needs to be taken up wherein the text books of all classes have to be revised to plug the gaps which existed in the earlier models. This has been done and a link between the different components of environment with real life has been lucidly explained in the chapters. He has also clarified that for Classes IX to XII, a separate issue based project guide is being provided and that project-work had been made compulsory for the students which will be graded. M.C Mehta, Environmental lawyer, strongly believes that unless and until a discipline is recognized it remains on the sidelines with very few serious takers. He has also emphasized the importance of the state to recognize the subject for the citizens to realize its importance. (Source: multiple pages from cseindia.org, Accessed on 23 April, 2016).

According to an interview by Dr. Jaishree Sharma, Nodal Officer for Environment Education at NCERT, following the NCF 2005, a workshop was held to orient textbook writers of the NCERT Textbook on how to approach to EE and the syllabus. Detailed discussions were done on how infusion may take place. Subsequently, a report was also prepared on how the infusion has been done (Source: <http://education-for-change.blogspot.in/2012/06/ncert->

approach-dr-jaishree-sharma-nodal, Accessed on 23 April, 2016).

The Ministry of Environment and Forestry (MoEF) also has key stake in EE, with more than 27 years of experience that has engaged state Nodal agencies, Centres of excellence and various associated expert institutions. It has a stake in keeping the priorities of environment and sustainable development at the core of education systems in order to keep the citizens aware of the concerns and actions required to resolve them. MoEF is providing the expertise gained over the years particularly with school systems, through programmes like Environmental Education in the School System (EESS) and Strengthening Environmental Education in the School System (SrEES). The EESS targets capacity building of teacher trainers, textbook writers and curriculum development. The flagship programmes of the MoEF like National Green Corps (Co-Curricular Eco Club approach), offer great insights and opportunities to support universalisation of EE.

4. Environmental Education Beyond Curriculum

In 1990, Hungerford and Volk presented a benchmark paper on Changing Learner Behavior through Environmental Education which affirms the convictions of many Children's Environment readers/ books that vital environmental learning takes place outside the classroom in children's homes and neighborhoods. Studies widely done across the world have repeatedly shown that knowledge about ecology and environmental problems, the main content of school curricula is not enough to produce environmentally responsible behaviour.

Hungerford and Volk note the paradox that most environmental education modules focus on imparting information; a strategy that tends to be ineffective by itself in changing behavior. In contrast, committed environmental action depends on a combination of factors that are usually acquired outside of school rather than in the classroom. Environmental sensitivity, defined as an empathetic connection with the environment, strongly correlates with behavior; and several studies suggest that children acquire sensitivity through positive outdoor experiences over extended periods of time in wild or semi-wild places, either during solitary play or activities with friends or family. Thus, it is necessary to recognize the importance of imparting EE outside the confines of the classroom in order to impart a deeper and more meaningful insight into the immediate environment of a student, while simultaneously promoting awareness and encouraging participation for its protection and maintenance.

4.1 National Green Corps (Eco Clubs)

India's National Green Corps (NGC) or the Eco Clubs Scheme is a unique opportunity to educate the youth on environmental issues. It is a national programme across India conceptualized and initiated by the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India. The MoEFCC is 'the nodal agency in the administrative structure of the central government, for planning, promotion, co-ordination and overseeing the implementation of environmental and forestry programs' (www.envfor.nic.in). The four major objectives for Eco-Clubs are to: (1) educate children about their immediate environment by increasing awareness; (2) impart knowledge about eco-systems, their interdependence and need for survival, through visits and demonstrations; (3) mobilize youth by instilling a spirit of scientific inquiry into environmental problems; and (4) involve youth in active environmental preservation efforts.

In 2001, the National Green Corps (NGC) programme was developed and provided the framework needed for the Eco Clubs to succeed. The NGC is implemented countrywide with an overall goal of 'spreading environmental awareness among school children'. Five years after the NGC program's launch in 2001, during the academic year 2005-2006, Eco-Clubs existed in nearly 68,000 schools across India, representing 150 Eco-Clubs per district. The goal for the MoEFCC in subsequent years was to reach an even higher participation level of 90,000 schools. This goal was reached in 2007, when the NGC Eco Clubs operated in 91,447 schools, engaging thousands of committed teachers and more than three million students in conservation efforts, making this one of the MoEFCC's most successful programs (MoEF Annual Report, 2007). In case of the NCT of Delhi, more than 2,000 Eco Clubs have been established in Government, Aided, Private and Public schools since its inception (personal communication with Department of Environment, Government of NCT of Delhi).

More specifically, the aim of the NGC is: 'to impart environmental education and to encourage and mobilize participation of school children in various environment education activities in their localities' (MoEF Annual Report, 2007). Furthermore, pursuant to this purpose, the following statement about NGC provides support for the MoEFCC initiatives for strengthening non-formal environmental education: "to educate children about their immediate environment and impart knowledge about the eco-systems, their inter-dependence and their need for survival, through visits and demonstrations and to mobilise youngsters by instilling in them the spirit of scientific inquiry into environmental problems and

involving them in the efforts of environmental preservation” (Source: envfor.nic.in/divisions/ee/ngc Accessed on 23 April, 2014).

This aforementioned goal is being achieved by establishing Eco-Clubs in every district across India with an emphasis on action-oriented environmental programs. The respective governments are free to set up as many Eco-Clubs as desired, yet financial assistance is only provided by the MoEFCC to a certain number of Clubs per district. The NGC-Eco Club scheme, as originally developed, operated through Eco Clubs formed in participating schools as follows:

- Each Eco Club needs to have 30–50 children expressing interest in environment-related issues.
- Each Eco Club is supervised by a teacher-in-charge (TIC), who is selected from among the teachers of the member school, based on interest in environment-related issues (or through appointment by the school Principal).
- Each Eco Club should be provided with resource material in the preferred language apart from a small monetary grant (seed allocation) of 2,500 Rupees per annum beginning from school year 2005–2006 (this amount in Delhi in the ongoing year is Rs. 20,000/- per Eco Club per year).
- A district implementation and monitoring committee supervises the programme, organizes training for TICs and periodically monitors the implementation of the scheme at district level. There are one or two master trainers in each district to assist TICs for smooth functioning of the Eco Club activities.
- A state steering committee oversees the implementation of the scheme.
- The state nodal agency coordinates the scheme’s implementation in the state and organizes related activities (e.g., training for master trainers).
- The national steering committee gives overall direction to the program and ensures linkages at all levels.

4.2 Vasundhara – A Lead Eco Club

To understand the functioning of an Eco Club, Vasundhara, the Eco Club of Kulachi Hansraj Model School (KHMS), located in Ashok Vihar, Phase III, Delhi, was extensively studied. Vasundhara is one of the lead Eco Club Schools in Delhi as selected by the Department of Environment, Government of NCT of Delhi (DoE, GNCTD). The School in which is located is one of the first EMS 14001-2004 certified school of Delhi. There are 17 other schools attached to this Eco Club and together they constantly works towards

protection of the environment and achieving a sustainable future through awareness generation and participation.

The Vasundhara Eco Club, led by KHMS, has been working meticulously in collaboration with various organizations/ NGOs. A key initiative by the Vasundhara Eco Club is the campaign on awareness about electronic waste recycling and management, setting up of waste collection bins in the offices nearby areas as well as in the school. The focus here has been to collect e-waste and prevent it from entering landfills. A total of 135 kg of e-waste was collected by the Eco Club in 2014, which was given to NOKIA for safe handling and disposal of this otherwise hazardous waste. Other projects of Vasundhara include practicing of composting wherein a sizeable compost pit has been prepared in the school nursery where dried leaves and grasses from the school lawn and vegetable peels from the canteen and home science lab are regularly fed. Vasundhara, along with the students of Manovikas Kendra, a Centre for the specially-abled children of the school and in collaboration with DEEKSHA NGO, maintain a herbal garden in which different varieties of herbal plants are grown and maintained by students.

As a lead Eco Club, Vasundhara conducts training programmes for teachers and students of all other 17 schools attached to it. Recycling of paper, rainwater harvesting, installation of wind-powered exhaust fans in the school to save electricity, segregation of wastes, R.O water purification plant wherein waste water from the plant is recycled and used in toilets and watering plants and use of Micro-Analysis Kits in labs to reduce the usage and release of chemicals into the environment are some other initiative of the Vasundhara Eco Club. In addition, tree plantation drives, adoption of a park, nature and biodiversity trails and celebration of significant environmental days are some other regular features of Vasundhara Eco Club.

Based on the interview conducted with the representative of the Eco Club as well as the students involved, it can positively be concluded that the students and the teachers were very proud of all their contribution towards the environment. The students of the school were also found to be effectively engaging in the activities of the Eco Club and displayed a responsible behavior towards the environment as they took care of the gardens in the school, looked after the work of composting and even conducted studies to find solutions to environmental issues. For example, students of IX grade of the school conducted a study to identify the principal sources of noise pollution in three countries namely India, Australia

and some parts of UK and did a comparative study by exploring the laws and policies set by the governments of the respective countries to regulate this problem. The results of the survey were presented in the school followed by an awareness campaign focused on making the world noise pollution-free.

It is clear that at least in the case of KHMS, students have been made considerably more awareness about environmental issues due to the presence of a functioning Eco Club. It can certainly be said with absolute surety that the adoption of the Eco Club scheme by Kulachi Hansraj Model School has been a positive step in ensuring consistent and long-term awareness generation on environmental issues in the students of this school.

5. Conclusion

With the introduction of formal Environmental Education at the School Level, and the simultaneous implementation of the NGC/ Eco Club Scheme, the Government of India has played its part in promoting and raising environmental awareness and sensitivity among the students. The implementation of EE in schools needs further research and improvement as it can be made better through further improvements in the syllabuses and branching out on the kinds of issues/ challenges taught in schools. Furthermore, to shape responsible attitudes of students towards the environment, compulsory field projects to environmentally sensitive sites may be taken up at the classroom level to introduce the students to the actual scenario of the environment. It is also felt that there may be a separate slot in the time-table for work solely dedicated to the environment in which discussions and debates on environmental issues can be taken up. In this way, every student can be sensitized and inspired to act responsibly towards the environment.

While a lot more can be done to encourage school students to work towards the protection of the environment, the first steps in this direction have been taken. Further research in this direction could shed light on the role of teachers as well as peers and projects, all of which could help foster a deeper understanding about the importance of nurturing and caring for 'our common environment' by students who are the future citizens and leaders of tomorrow.

6. Acknowledgement

The author would like to thank Dr. Govind Singh of the Department of Environmental Studies, Indraprastha College for Women, University of Delhi for supervising her Master's dissertation, which made this research paper possible.

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Smart City for a Sustainable Future: Is Delhi Ready?

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Abstract: Cities are the geographic nodes around which people gather for their livelihood activities. Various factors like resources, technology, education, medical innovations and environmental developments have shaped modern cities. However, with rapid urbanization and population growth, many cities are facing the problems of degradation, pollution, diseases and a poor quality of life. The major challenges before the urban growth centers have necessitated the formation of smart cities. Sustainable future of a city lies in the development of transport, infrastructure, environment, energy, ICT and people with a sustainability approach. The Government of India has launched a scheme to create hundred smart cities across the country, among which the National Capital of Delhi is a frontrunner. This paper attempts to study the existing infrastructure and facilities in Delhi in order to assess its readiness to be a smart city. It also attempts to analyze the citizens' perception about Delhi as a smart city through a primary survey. Although there are limitations in the current scenario of economic and environmental performances and people's perceptions, Delhi makes a strong case for becoming a smart city.

Keywords: smart city, urban infrastructure, Delhi, sustainable development.

1. Introduction

Cities are the greatest of human inventions. With the history in backdrop, cities manifest our technological innovations, socio-cultural interactions, economic structures and political systems. Cities are often equated with the idea of progress of mankind because it is the city in which the concept of a citizen was born. Anonymity, social order, civil society, economic progress and the ability to produce and consume are certain attainments of a city which make its existence special to human beings.

Starting from the early small size to house a few people, cities have grown to bigger areas with walls, boundaries, markets, production areas, streets, residential areas and civic facilities. With the rising population, almost half of the world's population lives in urban areas today (UN, 2011). The increasing urbanization rates suggest that people have looked at cities as places of leisure and work at a faster pace than ever before in human history. With the rapid growth of cities, there has arisen a variety of risks and problems in terms of resource scarcity, degradation, diseases and a basic quality of life. The situation has created an urgency to find 'smarter ways' to address the upcoming challenges. The search today is for sustainable pathways for growth and balance on the basis of experience and knowledge.

The most recent prescription for the sustainability of cities is to be 'smart'. This suggests the use of the best ideas to create an urban future that not only uplifts quality of life but continues to make cities vibrant, progressive and energetic spaces meant for citizens along with their interactions, production and communication processes. This needs to be done in a way that it is least costly to the economy and the environment. The concept of smart cities is essentially a manifestation of all such solutions towards urban problems centered around sustainability. It is important here to define as to what is a Smart City. While there is no single answer, there are certain multidimensional components and core factors which describe a smart city. There are a number of accepted definitions which attempt to define its framework and characteristics. According to Accenture, a Smart City delivers public and civic services to citizens and businesses in an integrated and resource efficient way while enabling innovative collaborations to improve quality of life and grow the local and national economy (NIUA, 2015). Smart cities are part of a process rather than a static outcome, in which increased citizen engagement, hard infrastructure, social capital and digital

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technologies make cities more livable, resilient and better able to respond to challenges. According to the British Standards Institute, smart city is the effective integration of physical, digital and human systems in the built environment to deliver sustainable, prosperous and inclusive future of its citizens. IBM defines a smart city as one that makes optimal use of all the interconnected information available today to better understand and control its operations and optimize the use of limited resources. CISCO defines smart cities as those who adopt scalable solutions that take advantage of information and communications technology (ICT) to increase efficiencies, reduce costs and enhance the quality of life (NIUA, 2015). Since smartness is dependent on the people's perception, smart cities should be more user-friendly and are required to adapt to the customized needs. A careful study of the successful smart cities of the world, as presented in Table 1, points at the following as the major factors that define a smart city: transport, infrastructure, environment, energy, ICT, people and an overall sustainability approach.

Table 1: Successful smart cities of the world (Source: Government of Singapore, 2009).

City	Core Areas	Achievements
Singapore	Transport	Urban transport system
	Energy	Widespread IT use
	Environment	Data sharing and open platforms
	Technology	Improved quality of life
	Community action	
Amsterdam, Netherlands	Technology	Smart energy grids
	Energy	Smart cards (transport)
	Transport	Online car sharing system
	People	Smartphone apps
San Francisco, USA	Environment	Parking projects for drivers
	Transport	Real time traffic data
	Technology	Safe mobility
	Data sharing	Making transit, walking, sharing preferable
	People's participation	
Curitiba, Brazil	Transport	BRT-integrated transport with land use planning
	Environment	
	Community	

In a developing country like India with a change in rural-urban composition, cities are facing pressure in terms of resources, energy, infrastructure and opportunities along with problems of pollution, congestion, health issues etc. With the announcement of the Government of India to build up smart cities, it becomes essential to assess the present situation (GoI, 2014). This study attempts to study the existing infrastructure in Delhi in terms of the

abovementioned parameters to know the 'readiness' of the city to be 'smart'. Since people are the most important stakeholders of this concept, a survey of people has also been done to know their preferences, perceptions, knowledge, the findings of which can be used as solutions and feedbacks to policy papers in future. The views can act as references for the planners for making better policy decisions which are directed towards betterment of people. Though the concept is at its 'conception' stage with very little information in the public domain, the analysis which is proposed here may act as a vital input to the government. The conclusion of the study therefore is more in the form of suggestions and recommendations, so that the city of Delhi is able to cope up with upcoming challenges with implementation of a successful model and continues to be sustainable in the long run.

2. The Delhi Megacity

2.1 The History of Delhi

The city of Delhi has a long political, social and cultural history which is a result of assimilation of different cultures through the centuries that the city has witnessed. The city dates back to the period of the Mahabharata and still stands testimony to the long past through the Sultanate rule, Mughal era and the British rule. The city has many famous monuments constructed by rulers with fine artistic taste and environmental relevance (Singh, 2008). Table 2 shows the evolution of Delhi over centuries whose traces can be found in many parts of the city till now.

2.2 Physiographic Features, Climate and Forest Cover

Located along River Yamuna in Northern India, between latitudes of 28°24'17" and 28°53'00" North and longitudes of 76°50'24" and 77°20'37" East, Delhi shares borders with the states of Uttar Pradesh and Haryana. Delhi has an area of 1,483 sq. km with the maximum length of 51.90 km and greatest width of 48.48 km. The physiography of Delhi is dominated by the Aravalli range, River Yamuna and the plains which are formed by the alluvial deposits. The Aravalli is covered with forest and is known as the Ridge, which acts as a barrier between the Thar Desert and the plains by slowing down the movement of dust and wind from the desert. The Ridge has 4 sections: Northern, Central, South-Central and the Southern, constituting the farthest stretch of Aravalli range. Often termed as the lungs of the city, this green belt has a moderating influence on the temperature and in maintaining an optimal environment (Singh et al., 2016). The average annual rainfall in Delhi is 714 mm, most of which falls in the months of July, August and September. Summers are hot with temperatures ranging 30-48°C.

Table 2: Chronological history of Delhi (Source: Jolly, 2010).

S.No.	Date	Name of Settlement	Founder(s)	Present Probable Site
1.	900 B.C.	Indraprastha	Yodhistra	Purana Quila
2.	1020 C.E.	Surajkund	Anang Pal	Suraj Kund
3.	1052	Lalkot	Prithviraj Chauhan	Near Qutub site
4.	1180	Quila Rai Pithora	Prithviraj Chauhan	Near Qutub site
5.	1301	Siri	Ala-ud-din Khilji	Near Hauz Khas
6.	1321	Tughlaqabad	Ghiyasuddin Tughlaq	Tughlaqabad
7.	1325	Adilabad	Moh'd Tughlaq	Near Tughlaqabad
8.	1327	Jahanpana	Moh'd Tughlaq	Siri & Rai Pithora
9.	1354	Ferozabad	Firoz Tughlaq	Near Feroz Shah Kotla Stadium
10.	1530-33	Din Panah and Shergarh	Humayun, completed by Sher Shah Suri	Purana Quila
11.	1638	Shahajahanabad	Shah Jahan	Old Delhi (Walled city)
12.	1911	Delhi	British capital	North of walled city, Shahajahanabad, Civil lines, Secretariat etc.
13.	1931	New Delhi	British (Lutyen, Baker)	Rashtrapati Bhawan, Connaught Place
14.	1947-date	New Delhi	Independent India	Present day New Delhi

2.3 Administrative Setup

The British presence in Delhi began in 1805 under the charge of Resident and Chief Commissioner of Delhi. In 1858, it was made a frontier province and transferred later to the newly formed Punjab province by the Lieutenant Governor. When the capital was shifted from Calcutta to Delhi in 1911, a separate Delhi committee was formed to oversee construction and management of civic affairs. After independence, Delhi became a part C state in 1951 with a council of ministers and legislature. The state reorganization commission in 1953 suggested its control under national government being the capital, with the formation of the Municipal Corporation of Delhi (MCD). Therefore, from 1956, Delhi as a union territory was administered directly by the President of India through a Chief Commissioner appointed under article 239 till the enforcement of Delhi Administration Act in 1966.

With the 69th amendment of the Constitution in 1991, Delhi was accorded a special status by designing it as the National Capital Territory of Delhi by insertion of Article 239AA providing for the creation of 70 member legislative assembly and 7 member council of ministers. Delhi was divided first into 9 districts (Fig. 1) and then subsequently to 11 revenue districts. A lot of changes have been introduced in the administrative structure (Singh, 2012). Delhi Transport Corporation has been transferred from the Central government to the Government of Delhi. Delhi Jal Board (DJB) is in charge of water supply and sewage disposal. The generation, transmission and distribution of electrical power in Delhi was under Delhi Vidyut Board (DVB) during 1997-2002.

It was later unbundled into six successor companies: Delhi Power Supply Company Limited (DPCL), Delhi Transco Limited (DTL), Indraprastha Power Generation Company Limited (IPGCL), BSES Rajdhani Power Limited (BRPL), BSES Yamuna Power Limited (BYPL) and North Delhi Power Limited (NDPL).



Figure 1. Nine administrative districts of Delhi (Source: delhi.gov.in, Accessed on 1 January, 2017).

3. The Smart Parameters of Delhi

Due to the immense opportunities, avenues and resources, the capital city of Delhi attracts a large number of people. The population of Delhi has grown at a rate of 21.2% over 2001-11 with a density of population 11,320 per sq. km

(Census of India, 2011). With the current population of more than 16 million, the city is facing multiple challenges. With rising demand for resources like land, water and energy, the future quality of life needs to be designed properly in harmony with the ecology. Smart Cities are conceived as solutions to the urban crisis. There are five major areas that are essential to be targeted for developing smart cities (Fig. 2). Smart people need to live in a smart city with smart transport, energy and water, information and communication technology and an above all a clean environment.

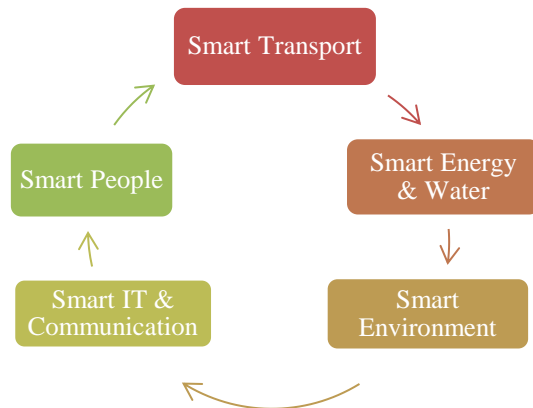


Figure 2. The smart connection.

3.1 Transport

Transport connects people. There are three major areas around which the transport sector operates: infrastructure installation, vehicles which run on these installations and operations including planning, financial issues etc. In order to sustain cities for a longer run, ‘sustainable mobility’ is required today in order to address its various challenges. While modes of transport need to be safe, comfortable and economical, these have to control pollution and congestion at the same time. Delhi has both public and private transport systems. The former includes bus, auto rickshaw, taxi, railways and Metro, owned by Government and/ or private players who operate in areas providing mass transport for people. Private transport means mode of transport owned by individuals or organizations largely for the private purpose like car, motor cycle, scooter, and cycles.

3.1.1 Bus

The bus service has been the largest and the oldest among the public transport system in Delhi. It is provided by Delhi Transport Corporation (DTC) since 1971. It operates in the city as well as across states. There are buses that ply between Delhi-Kathmandu and Delhi-Lahore. As a part of a green drive, all buses have been

converted to the clean fuel Compressed Natural Gas (CNG) in 2003. With a minimum fare of Rs.5 (non-AC buses) and Rs.10 (AC buses), the DTC service caters to the largest share of the transport demand of the state. It has approximately 5,000 CNG buses, 45 depots, and 21 bus terminals. Steps have been initiated to make buses better by introduction of low floor fleets making them more citizen-friendly. The Government of Delhi also has plans to install passenger information system.

3.1.2 Metro Rail

The public transport sector of Delhi has witnessed a major achievement with the introduction and successful operation of the Metro in the city. The Delhi Metro Rail Corporation (DMRC) was formed with equity partnership from the Government of India and the Government of the National Capital Territory of Delhi. It is an excellent example of eco-friendly mass transit system after it was recognized by the United Nations as the first rail system to reduce greenhouse gas emission by reducing pollution levels by 6.3 lakh tones every year. The stations, parking spaces and upcoming expansions are likely to be developed as Green Buildings. It is also using rooftop solar power plants at certain metro stations. Delhi Metro has also become the first ever Metro and Railway system in the world to be registered with the prestigious Gold Standard Foundation, which is a globally accepted certification standard for carbon mitigation projects. Table 3 shows the clear advantage of the Metro as a green option as compared with the other modes of transport.

Table 3: CO₂ Emissions from different modes of transport (Source: delhimetrorail.com, Accessed on 1 January 2017).

Mode	Value	Unit
Passenger car	67	g-CO ₂ /km/passenger
Taxi (CNG)	72	g-CO ₂ /km/passenger
Two Wheeler (Petrol)	28	g-CO ₂ /km/passenger
Auto Rickshaw (CNG)	35	g-CO ₂ /km/passenger
Bus (CNG)	27	g-CO ₂ /km/passenger
Metro	20	g-CO ₂ /km/passenger

DMRC has a fine record of providing timely service, safe and comfortable journey, user-friendly practices of smart cards, travel information guides, online recharge systems, interactive maps, mobile apps etc. under the supervision of trained personnel. Beside the six functional lines at present, construction is going on for extending it throughout Delhi and NCT. The fare ranges from Rs.8 to Rs.100 according to the distance covered. The services are provided daily from 5.30 a.m. to 11.00 p.m. It covers a total length of 213 km with 160 stations through a fleet

of 216 trains of four, six and eight coaches. The daily ridership of the metro service is 2.4 million on an average. This great success of Delhi metro has attracted greater public attention and is to be followed up in other cities in India.

3.1.3 Auto Rickshaws

Auto rickshaws are three wheelers that form a significant part of public transport in Delhi. They are run on CNG and are cheaper than taxis. With the mandatory installation of fitted electronic meters and fare charts, the fare is regularized. The guidelines provide for mandatory uniform, badges, first aid box, and driving license to be possessed by the driver. Installing GPS devices is also under consideration. Around two lakh autos ply across entire Delhi. The government is also taking steps to make autos safer by providing training and hiring women drivers especially to ensure safe travel by women during nights. Introduction of Pink Autos targeting exclusively women, equipped with panic buttons is another effort towards women's safety. However, there is a parallel system of running autos by mutually agreeable rates without the fare meter which has become a problem for this mode. Besides the safety issue, auto rickshaws need to be made more accessible and regular. Further services need to be generated for booking rickshaws with payment options of cash or card. If implemented successfully, this sector can provide economical, comfortable, safe and accessible transport to a significant number of commuters.

3.1.4 Ring Rail

The ring rail is operated in the National Capital Region covering Delhi, with adjoining regions of Faridabad and Rewari in Haryana, Ghaziabad and parts of Uttar Pradesh. Started in 1975 by the Northern Railways to transport goods, it started as a popular option. As the name suggests, the railway runs parallel to the Ring Road covering important areas of the city in a circular fashion. It is run by using electricity on EMU and DEMU systems on a broad gauge track. The fare structures are as per the Indian Railways fare policy with minimum Rs.2 and maximum Rs.6. Less preference by passengers and operational failures contribute to the present poor state of suburban railways in Delhi. Mostly, it covers areas having less density centres which do not connect with other transport networks. It also has problems of irregularity, lack of hygiene etc. At present, these tracks are largely used as a freight corridor with some passenger services at peak hours. During the Commonwealth Games 2010, efforts were made to revive the ring rail network which did not sustain later. In view of its great potential, the ring

rail needs to be restructured to make it an affordable, safe and comfortable option.

3.1.5 Taxi/ Cab

Another mode of transport common across Delhi is taxi/ cab. These are more popular among the tourists who are either outsiders or foreigners who hire taxis. Presently there are many private companies which dominate this field like Ola, Uber, Meru, Megacabs, Yo, Easy Cabs which are easily available and can be booked online. These are said to be pocket friendly with different deals, schemes and offers. However, these need to improve on their safety aspect after many incidents in the city. Fitting GPS track mechanisms and panic buttons, following stricter registration norms are some such measures to ensure quality service. Being comfortable and accessible, they provide services to cover greater distances and at all times, especially at night. Taxis registered with the Government run on CNG and can be booked by approaching the taxi stands. Delhi tourism provides taxi details, fares on their website. The vehicles, as per the radio taxi scheme 2006, call for mandatory display of boards, electronic meters, GPRS devices, verification of drivers, helpline numbers to make taxis economical, safe and comfortable.

3.1.6 Others

Apart from major public transport modes, there are other modes which fill up the gaps in this sector by providing last mile connectivity to areas where other public modes have no connectivity. These are pulled rickshaws, sharing vans, and e-rickshaws which are now widely accepted to complement the traditional transport sector. A pulled rickshaw is a human-powered transport in which the rickshaw is drawn by a cycle by the puller which seats 1-2 persons to travel short distances. Sharing vans are also popular in many stretches carrying 7-8 persons to major commonplaces like bus stands, metro stations, and market places. With lesser fares than a pulled rickshaw, their cost effectiveness is their major advantage as they run on a sharing basis. One major transformation came in the form of electronic/ e-rickshaws which are gaining popularity because of their low fuel cost, low fares, less human effort, electric motors and eco-friendliness. Efforts are made to regularize and register e-rickshaws by formation of policy which regulates their functioning.

3.1.7 Private Transport

Private cars and two-wheelers are largely used by individuals for private purposes. The increasing number of cars has become a major cause of concern. In order to tackle the pollution and congestion problems, the Government of Delhi has recently introduced the odd-

even car formula on an experimental basis. It has been a success and is going to be implemented again.

3.2 Energy and Water Resources

3.2.1 Energy

With rising population in Delhi, demand for energy is increasing rapidly. All sectors like industrial clusters, residential areas, office spaces, educational zones, transportation require energy. Energy consumption has increased from 19,666 million units in 2002 to 27,234 million units in 2013 with the per capita consumption of electricity being much higher than the national average. The domestic sector has the largest share in energy consumption at 44%, followed by industry at 25%, commercial 13% and agriculture 1%. The Government establishments and public works in the National Capital have a combined share of 17%. While the generation, transmission and distribution companies are responsible for the power supply to the city, Delhi Electricity Regulatory Commission (DERC) looks after regulatory matters, such as, rationalization of tariffs, transparency in subsidy policies and promotion of efficient and environmentally benign options. The state also has waste-to-energy plants with an installed capacity of 16 MW. It has 681 biogas plants with 90 solar photovoltaic pumps with present installed capacity of 2.53 MW. Although the energy sector is dominated by thermal power, alternative sources are under development. The net availability of power from the seven local power plants in Delhi is 1,213 MW whereas the central power projects supply 2,873 MW. With peak load during summer going as high as 5,653 MW, providing electricity to all is a serious challenge. Table 4 presents the peak load power demand of Delhi.

Table 4. Power Demand during peak load in Delhi (Source: DES, GNCT of Delhi 2014).

Year	Peak Load (MW)
2010-11	4720
2011-12	5028
2012-13	5642
2013-14	5653

The solution to this crisis is the development of alternate sources like solar power which the Government is considering. The outlay in annual plan in 2013-14 is Rs.100 lakh for promotion of energy efficiency and energy conservation. This includes promotion of solar energy by providing subsidy, mandatory adoption of energy conservation measures in buildings like building

codes, smart grids etc. Awareness campaigns have also been initiated.

3.2.2 Water

With only one natural source of water, River Yamuna, Delhi sources its water from River Yamuna, Ganga, Beas and Ravi and Bhakra storage and Munak canal. There are five water treatment plants to distribute water across the city. Delhi Jal Board is responsible for procurement and treatment of allocated raw water and provide bulk supply of treated potable water. As per the Master Plan of Delhi, the water demand is around 1,380 million gallons per day (MGD) for the projected 23 million population (MPD, 2021, 2007). Water production on a regular scale is estimated around 1,290 MGD, thereby leaving a gap of about 90 MGD. The grim water situation of Delhi is reflected in Table 5.

Table 5: Water situation in Delhi (delhijalboard.nic.in Accessed on 1 January, 2017).

Year	Demand (MGD)	Production (MGD)	Shortfall (MGD)
2000	792	630	162
2005	918	650	258
2009	1020	810	210
2010	1080	845	235
2011	1380	1290	90

Apart from the scarcity, the state of River Yamuna is worrisome because of the increased pollution to an extent that the river has been declared almost 'ecologically dead'. This means there is now a greater dependence on groundwater and supply from neighboring states like Haryana and Uttar Pradesh. With greater exploitation of groundwater, the quality and quantity of water is not proportional to the requirement. The ground water situation in Delhi is alarming. With low water table in almost every region except central and north districts, the quality of water is also deteriorating. The water is polluted by the presence of heavy metals, calcium, magnesium salts and untreated sewage which render it unfit for drinking (Singh, 2012). Thus, the management and regulations will be critical in future to secure human and environmental health both of which are part of the millennium development goals.

Sustainable water management in Delhi requires optimized resource utilization, regulations banning withdrawal of ground water, storage of rain water in Yamuna and rain water harvesting. The Government is planning to build up additional capacity by constructing three new reservoirs and two new water treatment plants.

Dual pipe system for flushing purpose only will be implemented in all group housing societies and new colonies to be developed in the new urban extension areas by the DDA. Reclamation of sewage water following the North East Water of Singapore using ultra-filtration, reverse osmosis and UV treatment processes may be taken up. Reducing wastages through repair of supply pipes, using waste water for purposes like construction may also be introduced.

3.3 Environment

A Smart city must have smart environment so that it is able to cope up with the challenges and adversities it faces due to the natural and anthropogenic causes. Environment includes the natural environment comprising air, water, soil and forests as well as the built environment which includes buildings, parks and green spaces created or modified by people. It impacts indoor and outdoor physical environments and social environments and subsequently the health and quality of life.

3.3.1 Green Spaces

It is essential to have green spaces in an urban center. The Delhi Ridge, often termed as the 'lungs of the city', acts as a pollution controller, climate moderator, preventer of soil erosion and a habitat for birds and wildlife. The forest cover of Delhi is less than the prescribed 23% necessary for ecological sustainability. The city has more than 20,000 parks and gardens, 40 city forests, 5 ridge areas, 2 biodiversity parks and 1 wildlife sanctuary managed by development authorities and municipal corporations. Delhi Parks and Garden Society, registered under Societies Registration Act, 1860 has the objective of greening environment by identifying vacant spaces in coordination with local bodies. Delhi also has the presence of roadside greenery called green belts.

3.3.2 Green Buildings

An important aspect in a smart environment is to have sustainable urban designs under healthy urban planning. In order to have sustainable habitats, councils like GRIHA (Green Rating for Integrated Habitat Assessment) interact on scientific and administrative issues which are adopted by the Government of Delhi. It also provides ratings to buildings. The Government of Delhi has brought out an 'Action Plan for Implementing the Climate Change Agenda 2009-2012' with an aim "to reduce the energy consumption in existing buildings by 30-40% in relation to the conventional buildings, make at least 250 green buildings by adopting the green building standards and 50% buildings be retrofitted for this and another 50% new buildings be made."

The Government of Delhi has made mandatory implementation of the Energy Conservation Building Code (ECBC) in government buildings and building complexes (new construction) including buildings and building complexes of municipalities, local bodies, boards, corporations, Government aided institutions and other autonomous bodies of the Government of NCT of Delhi. It has been taking measures in site selection, orientation of buildings, rain water harvesting, using LED and solar lights, re-use of water and efficient waste disposal with major portion being recycled.

3.3.3 Pollution

Pollution is a major threat to life in Delhi. Along with the poor quality of water, the Air Quality Index also depicts a worrisome picture of Delhi. The high levels of PM 2.5, ground level ozone, carbon monoxide and SO_x / NO_x have made the city prone to health risks. The positive benefits of conversion to CNG are largely lost due to the ever increasing number of vehicles in the city. The figures in Table 6 reflect the huge pressure of vehicles on Delhi roads.

Table 6: Registered vehicle in Delhi (Source: DoE, GNCT of Delhi, 2014).

Vehicles (Number)	Private Cars	Two Wheelers	Taxis
2012-13	2474476	4962507	70335
2013-14	8293167	5297697	78686

Delhi is also facing increased noise pollution levels in Delhi/ NCR beyond permissible limits as formulated by the Central Pollution Control Board. The industrial and commercial areas as well as the congested roads are the hubs of the highest pollution levels.

3.3.4 Waste Management

A Sustainable Environment should also take care of its wastes generated from different activities because untreated and inadequate waste management leads to pollution, degradation and health hazards. Approximately 9000 million tonnes of municipal solid waste is generated daily in Delhi. Disposal of solid wastes has become a major issue with huge sanitation landfills causing air and groundwater pollution. Three of the four existing landfill sites have become over-full and fresh sites are not available with states forming boundaries around Delhi (Table 7). The municipal bodies and department of flood control are delegated with the responsibility of waste management. Debris from construction sites, non-biodegradable materials, e-waste in open areas and the

Yamuna causes major pollution and health risks. Sustainable waste management strategies require segregation, pre-treatment, followed by incineration/ autoclaving/ irradiation as per the waste with finally transportation to the landfill sites. There are waste management practices and rules according to the type of waste like bio-medical, e-waste which should be followed. Another aspect of waste management is to optimize the use of resources with the focus on reduce, reuse and recycle. The draft concept note of the Government of India on smart cities has also highlighted the importance of clean cities with appropriate waste management.

Table 7: Landfill sites and waste-to-energy capacity (Source: DoE, GNCT of Delhi, 2014).

Landfill Site	Waste (tons/day)	Power Generation (MW)
Okhla	1950	16
Ghazipur	1300	10
Narela-Bawana	3000	24 (yet to be functional)
Bhalaswa	500	-

3.4 Information & Communication Technology

The development of a ‘digital city’ within the ‘smart city’ ensures online presence of Government through websites, facilitating government-to-citizen interaction in terms of citizen charters, providing facilities like social networking, e-commerce, e-banking with emphasis on sectors like intelligent transport systems, education, health, administration, healthcare etc. These are the areas which Delhi needs to emphasize in order to improve the quality of life through smart information and communication technology (ICT). The department of information technology was set up in year 2000 to implement IT policy of the government in the National Capital Territory of Delhi. The aim was to put technology to its highest and best use through the government of Delhi in all departments and autonomous bodies to improve the administration of services and programs.

The state has implemented a Citizens’ Charter with an aim to provide an efficient delivery of services in the most effective manner. The idea will also bring transparency and accountability on the part of government by building trust and confidence of the citizens. The IT policy of Delhi is governed by 6 E’s, namely, e-governance, equality, education, employment, entrepreneurship and economy. Realizing the huge potential and application of IT in Delhi, the government has announced development of free public Wi-Fi access zones. Initiatives of compulsory

computer labs, online student management systems, library management systems are emphasized by the government in this regard. The upcoming areas for the use of ICT are health, transport, tourism etc.

3.5 Smart People

All efforts are eventually meant for the best utilization of the human potential and facilitating a better life for the citizens. Smart dwelling requires optimal housing, education and health services along with optimal resource utilization, better communication and technological advances. While these are the necessary conditions for better living, the sufficiency condition is the attitude towards environmental protection, conservation of resources and preservation of heritage monuments. This stewardship can lead to intergenerational transfer of good living.

3.5.1 Housing

Like most megacities, Delhi has a wide range of residential facilities spread over various localities. There are highly developed residential areas in many parts of Delhi. However, people with limited means for housing often end up living in slums or unauthorized structures. A smart city cannot be visualized in this scenario. These slums are devoid of basic facilities like drinking water, sanitation, education and health. The growth of slums has resulted in environmental degradation as well as social tension and other problems. The general policy adopted by the government is two- fold. On one hand, no fresh encroachment shall be permitted on public land by the land owing agencies. On the other hand, the past encroachments in existence till 31st January, 1990 will not be removed without providing alternatives. This creates a dilemma in treating the current dwellers and the new comers. If a clean city is to be made, then clearing the slums is a challenge. Similar attention is paid to the rural villages in Delhi with the constitution of Rural Development Board for Delhi in 2004 to ensure integrated rural development. The board formulates plans with priority projects and schemes to implement the Rural Area Plan. The focus is to provide solutions to the problems of slums, villages and to restrict their growth in future. It also specifies that the new buildings or housing projects should be finalized in a way which optimizes the use of energy, water, space and environment.

3.5.2 Education

Education is considered to play an important part in realizing the full potential of individuals. Delhi records a literacy rate of 86.20% comprising male literacy at 90.90% and female literacy at 80.80%, both higher than the national average. The number of recognized schools

in Delhi is 5,453 with the number of enrolled students in schools as 43.95 lakh in 2013-14 with a student: teacher ratio of 32:1. Government schemes like Mid-day Meal, *Sarva Shiksha Abhiyan* (drive for universal education) have been able to increase the enrollment rate. Delhi also has the best institutions of higher learning in the country, namely, universities, colleges, technological, medical and management institutes. The sector needs to be coupled with technology to make education more effective which provides future opportunities for employment in different sectors. The city has 9 district employment exchanges with one online portal giving details about the upcoming jobs and preparation of employment manual by jobseekers who register at the employment portal. Therefore, applying the IT in these sectors can yield better results leading to improvement in quality of life.

3.5.3 Health

Being healthy is a right of every citizen which includes physical, social and psychological wellbeing. With congestion, changed lifestyles, and problems of pollution, citizens in the city are facing severe health problems like obesity, cardiovascular diseases, mental stress, respiratory disorders that inhibit individuals to realize their full potential. A megacity like Delhi has a greater burden. Being the capital city, people from neighboring states come to Delhi for getting better treatments. It has the location of major hospitals with specialized wards and clinics. There are 95 government hospitals, 1,451 dispensaries, 267 maternity homes and sub-centers with a total capacity of approximately 47,398 beds. The current state of the health sector needs improvements in terms of its functioning which is largely affected by overcrowding, especially at the government hospitals which are more economical. Units for women and child care also need improvement by enhancing public confidence through people-friendly approaches. Cleanliness is yet another issue which needs to be addressed. The health sector at present is largely dominated by private hospitals which are by far more costly. One transformation could be the use of ICT in this sector. Another aspect of better health implies a healthier life style, exercising, cycling etc. People should be encouraged to opt for bicycles to commute shorter distances by making cycling safe in the city. Ensuring cycling tracks will serve the dual purpose of healthy living and eco-friendly ambience. Walking as a practice is also helpful. This needs commitment by people to make efforts to have smart health.

3.5.4 Heritage Sites

Though heritage or monuments have greater historical significance and are a part of built environment, the fact that it is meant for people makes it significant. Delhi has

a rich history and monuments are found all over the city. The city has a great potential for being developed as a 'heritage city' within the broader concept of smart city. The government alone cannot realize the idea in practice, it needs equal participation and support of citizens who should cooperate to maintain and preserve the present state of our heritage. As guardians of the city, they have to inculcate a habit of ensuring their cleanliness and a sense of stewardship towards the future citizens. Therefore, heritage is another aspect which needs to be taken care of in the proposed model of smart city. 'Smart people' is a two way approach. Along with government initiatives, it needs a citizen-centric view to make people feel a sense of ownership that will make their participation voluntary and broad-based.

4. Citizens' Perception: The Survey

A smart city should not only be a public policy, it should also be in people's perception. A survey was conducted to assess how the citizens of Delhi rate the status of transport, energy, water, waste, ICT, environment and awareness about being smart. A random sample of about 50 people from different groups of income, age and professions were chosen for the same. The findings of the survey are furnished below.

1) Knowledge about smart city: 60% of the respondents were aware and 40% were not. 2) Sources of knowledge: Newspaper, television, internet are the dominant sources of information as compared to magazines and radio. 3) Mode of transport: Ridership in metro 32%, bus 22%, auto rickshaw 14%, taxi 6%, car 9%, two wheelers 10% and others 7%. 80% of the respondents felt that metro and bus are cost effective, safe and comfortable modes of transport. Bicycle is not a preferred mode for the majority of the sample because of traffic congestion, inadequate cycling lanes and insecurity despite its environmental benefits. Among those owning vehicles, 37% of the households have at least one vehicle and 31% having 2 vehicles, of which around 41% of the vehicles are older than 10 years. 4) Energy use pattern: The electricity bill depends on the use of electrical gadgets and family size. More than half of the population surveyed pay a bill ranging between Rs.200 and Rs.3000 per month which they feel is justified. The dominant (73%) type of cooking fuel is LPG cylinders while 23% use piped gas and only 4% use firewood, kerosene etc. 5) Water availability: 83% of the total water use comes from the municipal supply, 15% hand pumps and the rest from water tankers. The average water bill is Rs.100-200 per month while a large section of the poor do not pay any charge. The duration of water supply in general varies between 6 to 16 hours per day. 6) Environment: 87% of the respondents

are aware of the problem of pollution in air, water, noise and soil. 11% of them felt that the solution is the responsibility of the state, 17% voted for the communities, 6% for individuals and 66% felt all agencies need to collaborate for mitigation of pollution.

7) Waste Management: Most people use dustbins for kitchen waste and general household waste. Newspapers and e-wastes are mostly sent to scraps and polythene is generally reused. Burning and open disposal were found to be very rare. 8) Heritage City: While everyone felt the need for protecting historical monuments, only 14% were in favor of strict laws, 26% for economic fines, 12% for individual awareness and 48% for all of these. 9) IT and communication: 84% of the respondents use the internet for various purposes. While 30% use it for education, 26% use for social networking, 25% for professional reasons and 19% for e-commerce and e-banking. 10) Miscellaneous: People revealed strong preference for government initiatives in areas of health and education. They showed willingness to install energy efficient devices and participate in citizen-friendly initiatives towards environmental protection. 11) Delhi as a smart city: 37% of the respondents felt that Delhi should be a smart city while the others are either ignorant or indifferent.

The citizens of Delhi have revealed reasonably good awareness about the concept of smart cities. The current scenario of water and energy resources is not at the expected level. The transport sector has problems of availability, safety, economy and pollution too. However, the people of Delhi have clean habits regarding the choice of fuel and waste management. They are exposed to the use of smart ICT and e-services. There is a definite need for improvement in the social sectors. The role of the government is also felt strongly. Those who are aware of the smart city concept are ready to participate in this new venture that the government has already initiated. With requirements for certain developments and some already initiated steps, Delhi can surely be visualized as a future smart city.

5. Concluding Remarks

5.1 Recent Developments

Delhi Government has announced to develop Rohini, Dwarka, and Narela areas as sectors of the smart city with improvements in water, electricity and Wi-Fi connectivity. Operational and business models of public bicycle sharing scheme is under process. Pollution will be reduced by 25% by repair of roads and broken footpaths. The plan includes grass to be planted on dusty patches with a plan to evolve a unified air quality monitoring

system. The plasma gasification system and the water recycling model of Singapore is being studied for possible implementation. The National Green Tribunal (NGT) has planned to ban all diesel vehicles that are older than 10 years, construction activities on road and open burning of crop remnants in neighboring states of Delhi. The odd-even car formula is also in place to curb vehicular pollution. Companies have been invited to devise best practices of a smart city. Installation of roof-top solar panels is being promoted on a priority basis. The Union Cabinet has given nod for building 100 Smart cities after it was announced in the Union Budget 2014-15 with an outlay of Rs.48,000 crores. Each city will be given an assistance of Rs.100 crores per year for 5 years. "The mission is to recast the urban landscape of countries by making cities more livable and inclusive besides driving economic growth". The projects for future smart cities will also be invited through 'smart city challenge'.

5.2 The Draft Concept Note

The Government of India has prepared a draft note available in the public domain which discusses the scheme of setting up hundred smart cities. With its focus on the smart parameters, it tries to design a sustainable growth plan. Largely, it needs to prepare a master plan with a broad vision with small plans in its ambit so that each sector is focused in this larger approach. State Governments will be supplemented with financial resources for capacity building. This will be supplemented by building a program which encompasses training, education, database and personnel for effective implementation. The draft plan discusses the key strategies of the project encompassing the planning, organizing, and implementation of smart cities.

5.3 A Strong Case for Delhi

People make cities and thus smart people make smart cities. The city of Delhi is unique in terms of its history, heritage, demography and culture. Being the capital it has continued to attract people like any other city. With challenges posed due to the issues of urbanization, it has to strive towards making future goals of social and environmental sustainability, achievable with an aim to be economically competent. Therefore, it has to modify its present growth pattern and move towards the idea of a smart city. As observed from the secondary information, Delhi has high potentials to come up as smart city. Although the current state of resource use, transport systems, environmental standards etc. are not at par with the best international standards, there is a large scope to improve upon those and move towards a smarter solution. This micro-level study also revealed that the citizens of Delhi are ready to take part in this endeavour in every

possible way. The macro motive of building this city will serve the micro purpose of its stakeholders by providing a better quality of life. The smart city model has been successful in some major cities of world. With the proposal of the same in India, a city like Delhi represents a strong case. It has the crucial presence of infrastructure which has the potential to transform the scenario. From deficient resources to effective resources, from restricted to open access, from degraded to improved state of environment, from worse to better quality of life, all can be achieved with this visionary idea. This needs not only effective planning, finances, vision and implementation but also a constant support from the citizens who are the major stakeholders in any urban endeavour. The Government is the major actor which needs constant dialogue, interaction with people and cities that have previously been successful in this initiative. With the Government of Delhi taking a great initiative, a bright future is expected when Delhi will become a smart city with smart people living a smart life.

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Implication of Household Use of R.O. Devices for Delhi's Urban Water Scenario

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Abstract: The present research contribution attempts to study the increasing dependency of households in Delhi on R.O. devices and brings forward its implications on Delhi's urban water scenario. The research focuses on five colonies in Delhi where preliminary water quality assessment was carried out so as to conduct a need assessment of installing R.O. devices versus the actual installation of these devices in individual households. Reverse osmosis is essentially a technique to reduce the hardness of water and the process involves demineralization or de-ionization of water by pushing it under pressure through a semi-permeable membrane. Consequently, an R.O. device is effective in households receiving water with high Total Dissolved Solids (TDS). However, an R.O. is neither required nor effective in households receiving water with low TDS, which were noted in the study area. This is because R.O. devices are not an effective method against biological impurities. Despite this limitation, over 78% of the households in the study area were found to rely on R.O. devices as a coping strategy against impaired municipal water supply. While some of these R.O. devices are also fitted with UV-filters (which help address biological impurities in water), the large-scale use of R.O. devices in households that do not require this technology poses a serious threat to urban water sustainability in Delhi.

Keywords: urban water, water supply, Delhi, R.O., water management.

1. Introduction

Water is a basic human requirement and a critical resource for the survival and sustainability of any urban centre. India's National Capital Territory (NCT) of Delhi is well aware of this fact and has been struggling to bridge the gap between water demand and supply (Singh, 2011).

With a Census population above 17 million and rising (Census of India, 2011), supplying drinking water to all the households of Delhi is becoming an increasing challenge for the Delhi administration each passing day. The high water demand of the NCT of Delhi is also the reason for the high pollution of River Yamuna which flows through the city and is the principal source of its freshwater supply (Singh, 2016). Despite consuming a major part of the flow of River Yamuna, the Delhi administration is still not able to meet the water demand of the city. Water shortage, as well as issues related to water quality in the municipal supply, have led to the development of coping strategies by the households in Delhi households (Zérah, 2000). One such coping strategy, mainly against impaired water quality, is the installation of reverse osmosis (R.O.) devices.

A Household R.O. device is a water treatment device which takes water supply from the tap as the intake, pushes the water through a semi-permeable membrane which retains most of the solid dissolved in water and provides largely chemical-free water as output (for drinking), along with releasing "reject water", which is rich in dissolved solids, as waste water. Reverse Osmosis can be defined as a process by which a solvent (in this case, water) passes through porous membrane in the direction opposite to that of natural osmosis when hydrostatic pressure > the osmotic pressure. Reverse Osmosis (R.O.) devices thus help reduce Total Dissolved Solids (TDS) in water. Despite their high cost (both installation and maintenance) R.O. devices are becoming increasingly popular in urban households across Delhi as water purification devices. Their popularity can indeed be also attributed to the fierce marketing as well as instilling doubt in the mind of the user over consistency in the ability of city administration to supply clean drinking water (Eureka Forbes, 2017).

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The present study attempts to explore the implications of the increasing popularity and installation of R.O. devices by urban households in Delhi. The principal objective of a R.O. device is to reduce the TDS of water. R.O. is therefore a requirement for households which receive water with high TDS values (>500.0 mg/l). One of the key motivations behind this study was therefore to analyse the TDS values of water being received by the households who are installing R.O. devices. A household R.O. device also leads to large-scale wastage of water, which has otherwise been sent as water supply (thus is meant for drinking as is). The research tries to carry out a need analysis of installing R.O. devices in Delhi and investigates the implications on Delhi's urban water scenario.

2. Study Area

The study is focused in the National Capital Territory (NCT) of Delhi which has a geographical area of 1,483 sq. km. The residential areas selected were located across different parts of NCT of Delhi (Fig. 1).

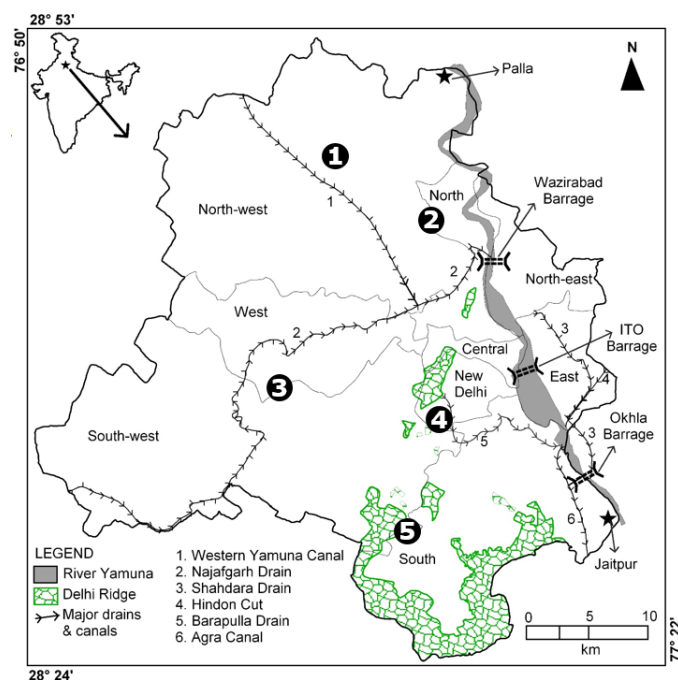


Figure 1. Map of Delhi showing the location of the five residential colonies (1-5) selected for the present study.

A total of five residential areas were identified to carry out this study (Table 1). The residential areas were selected to help develop a holistic understanding of the research problem in the entire NCT of Delhi. The residential areas selected corresponded to North-west, North, West, New Delhi and South Delhi districts of the NCT of Delhi.

Table 1. Residential areas selected for this study.

S. No.	Site ID	Details
1.	RS9	Rohini Sector 9
2.	WPC	West Parmanand Colony
3.	TN	Tilak Nagar
4.	LBN	Laxmi Bai Nagar
5.	VKC	Vasant Kunj, C-Block

3. Materials and Method

The study is a pilot investigation and was carried out in the month of October-December 2016. Five residential areas were identified in the NCT and 10 households (HHs) were randomly selected in each of these residential areas ($n=50$). Informed consent was taken from all the participants. Each HH was made to fill a survey sheet to find out the status of their access to 'clean, drinking water' on a daily basis. The preferred person in the HH for surveying was chosen to be a woman resident in each of the 10 HHs. Municipal water supply and R.O. outflow (wherever found) were sampled for TDS using HANNA portable pH/ conductivity/ TDS Meter (HI-9812, USA). Repeat sampling for municipal water supply and R.O. outflow was conducted at a two day interval for 30 days from one HH in each of the five selected residential areas subsequently. The data so obtained was analysed using descriptive statistics, and is presented below.

4. Observations

A detailed analysis of the HHs survey revealed high dependence of the residents on R.O. devices. 78% of the surveyed population ($n=50$) was found to have a functional R.O. device installed in their house. In total, four type of water purifiers were found in the study, while 8% of the HHs did not have any water purifying device installed in their house. 56% of the HHs were found to have a R.O. device installed, while 22% of the HHs were found to have a R.O. + U.V. device installed in their houses (Fig. 2). 10% of the HHs were found to own only a U.V. based water purifying device. 4% of the HHs surveyed were found to own a non-electronic water purifiers (Fig. 2). In the 8% HHs who did not have any water purifying device, almost all the HHs agreed to boiling water before drinking. However, these HHs also reported that on some days water was directly consumed from the tap by them without treating it in any way.

The supply water flowing out of the drinking water tap was collected and tested for TDS value in each of the 10 HHs in each of the selected five residential areas. The data so obtained was plotted as box-plots (Helsel and Hirsch, 1992) in the same graph so as to compare the TDS values in municipal water supply across the five residential areas.

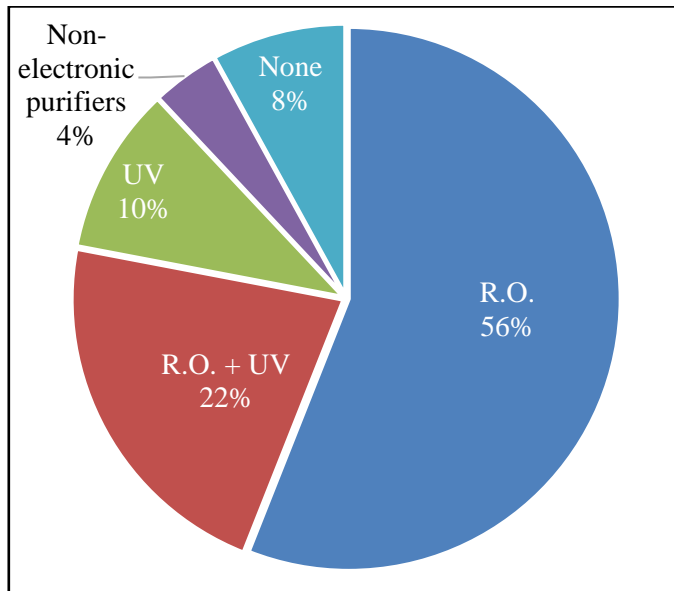


Figure 2. Percentage dependence on water purifying devices in the surveyed population (n=50).

The box-plots made using the TDS values obtained from 10 HHs in each of the selected five residential areas were also compared against the desirable and permissible value of TDS in drinking water (500.0 mg/l and 2,000 mg/l respectively), as prescribed by the Bureau of Indian Standards (BIS, 2012). The box-plot based descriptive statistics analysis shows that the median TDS value in all the sample population (n=50) is well within the prescribed desirable standard value of 500.0 mg/l (Fig. 3). Two of the five selected residential areas (WPC and LBN) do not note TDS above 500 mg/l at all, while the VKC residential area seems to have maximum HH receiving supply water with TDS values above the prescribed standard of 500.0 mg/l. On the other hand, the LBN residential area, which is located in the New Delhi district of Delhi, is found to be receiving water with lowest TDS values.

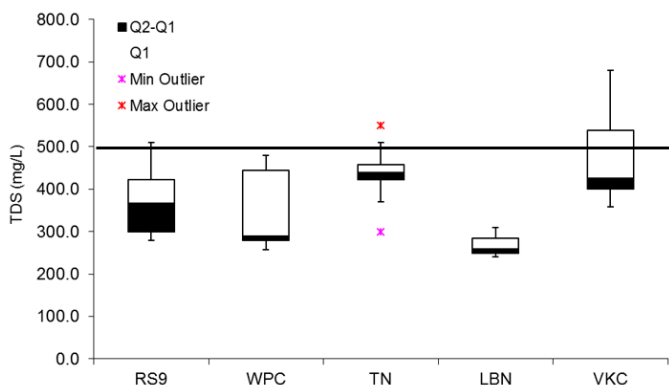


Figure 3. Box-plot analysis of TDS data collected from the five residential areas (RS9, WPC, TN, LBN, VKC).

The maximum value of TDS in the drinking water supply noted for the residential area RS9 is 510.0 mg/l, for WPC is 480.0 mg/l, for TN is 550.0 mg/l, for LBN is 310.0 mg/l and for VKC is 680.0 mg/l. It was therefore found that all the HHs surveyed receive water which is either well within the desirable level of TDS or between desirable and permissible level of TDS as prescribed by the BIS (2012).

The TDS data collected from municipal water supply, R.O. outflow and R.O. Reject (water discarded by the R.O. device as part of its inherent functioning) was further analyzed to find out the range difference between these values. Due to space constraints, data analysis from only one residential area site (RS9, Rohini Sector 9) is being presented and discussed. A similar scenario was observed in all the other residential areas. The RS9 residential area site has only 6 HHs who were found to be using a R.O. device. The TDS value of the intake water, outflow water and reject water were plotted on the same graph for all the six HHs at RS9 site to draw comparison among these three (Fig. 4). High correlation coefficient ($r=0.991461$) between TDS values in intake water and reject water indicates that higher is the TDS value in the municipal supply water, greater is the wastage of water from the R.O. device. This is an interesting observation which implies that wastage of water from R.O. devices located in individual households can be controlled by the municipal water supplying agency to some extent by providing water with lower TDS levels.

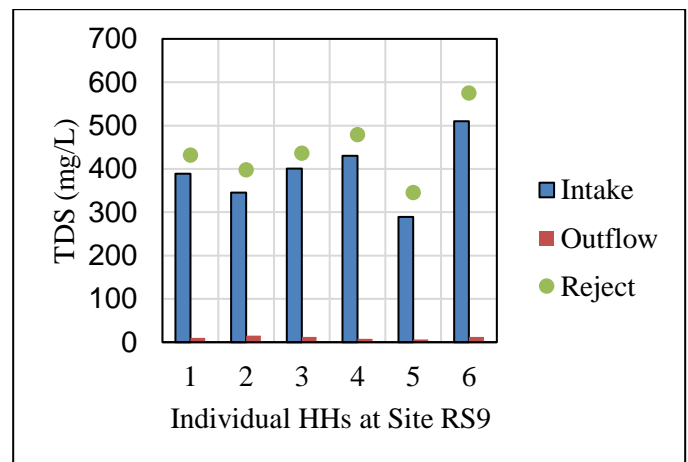


Figure 4. TDS value in intake water, outflow water and reject water from R.O. devices located in the 6 Households of the RS9 residential area.

The TDS value in outflow water, which is consumed by the residents, ranges from 6.0 mg/l to 15.0 mg/l in the six sites surveyed at RS9 residential area site. This means that

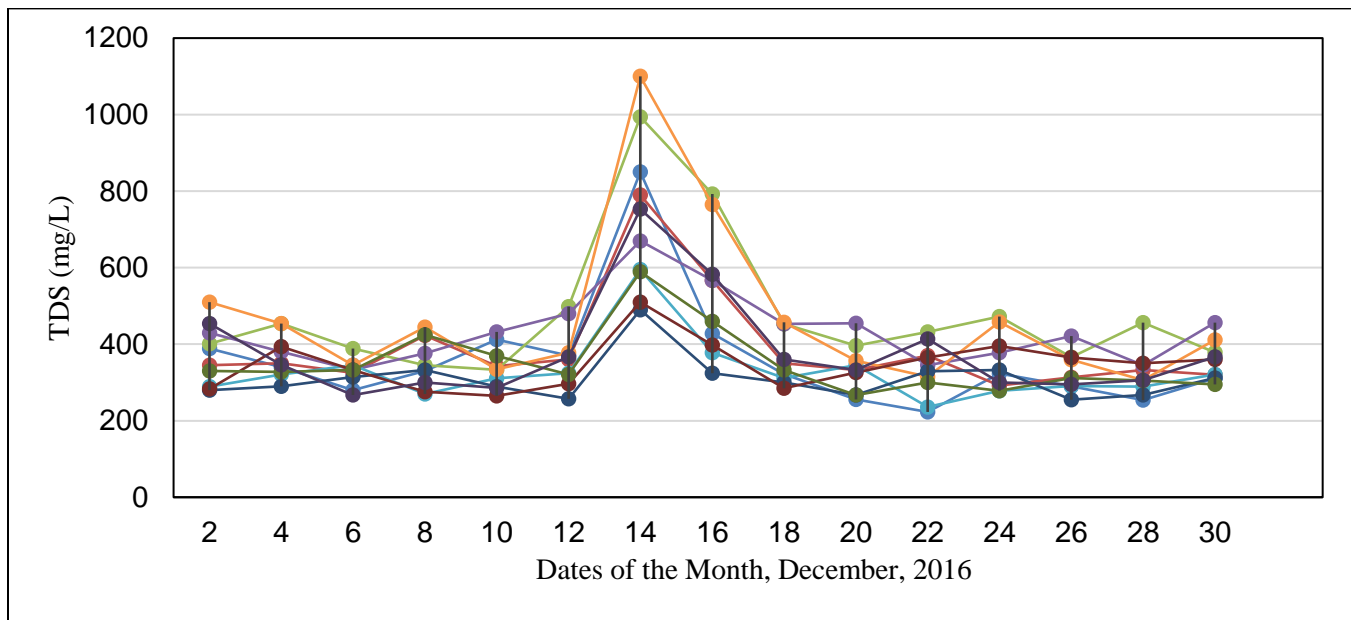


Figure 5. Monthly variation of TDS in municipal water supply recorded in the supply water from two Households from each of the five residential areas sampling sites at an interval of two days. Each line represents TDS value from one household and each point represents the date of the month.

the residents who use R.O. devices are consuming water with very less dissolved solids. This needs further investigation especially in the direction of finding out the impacts (if any) of consuming water with very low TDS for long durations, over months and years.

The data analysis until now seems to indicate that residents either do not require the installation of an R.O. device or very few of them need to install one as a necessary requirement. However, further analysis of the data collected in this research work has a different story to tell. Figure 5 brings forward an interesting insight into the municipal water supply system in Delhi. It represents the TDS value in the municipal water supply in different Households over a period of an entire month. The period of month investigated in the present study is December, 2016. The data shows that while the TDS in the water supply over a good part of the month remains less than 500.0 mg/l, there are one or two days observed in all the residential areas when the TDS value exceeds the 500.0 mg/l considerable (Fig. 5). On some days, the TDS values reach to the double that of the desirable value, giving a distinct taste to the water. Further analysis of water samples is required to establish the constituents of this water with high levels of TDS. However, at this stage it can be said with absolute surety that in terms of water quality, the municipal water supply system lacks consistency. It is perhaps this reason why the R.O. devices in Delhi continue to gain popularity in Delhi.

The survey carried out as part of this research work revealed that 88% of the people consuming R.O. water no longer find the taste of non-R.O. water acceptable. 98% of the people surveyed have not consumed water from a public facility in the last one year. At the same time, 30% of the people surveyed preferred to reach home to have water, if for example, they got thirsty in a market place and 62% choose to buy bottled water in such a scenario. None of the respondents would drink water from a public facility in case they feel thirsty while in a marketplace. Only 6% of the respondents remember seeing a public drinking water facility in the last one year.

5 Discussion

The United Nations considers water a basic human right (UN Water, 2009). This has motivated Governments across the world to provide water to its citizens at a subsidized cost. Delhi took a leap ahead and has made access to basic water supply free for all its citizens. Most water users in the city of Delhi are paying no money for receiving water up to a certain volume. However, water pricing has always been a challenging and complex problem (Rogers et al., 2002). Therefore, although water has been declared a free resource in the NCT of Delhi, large scale use of R.O. etc. devices indicates that Households in Delhi are actually paying a heavy price for obtaining clean, drinking water. While initial investigation of the municipal supply water in the NCT of Delhi does not seem to warrant the need of R.O. devices,

a more detailed investigation highlights the need of these devices in the households of NCT of Delhi. Due to this, the sale and use of R.O. devices will only continue to rise. This has two direct implications, one that large volumes of municipal supply water will be further “purified” in R.O. devices at the household level and will be wasted as reject water. Second, the residents of Delhi will continue to consume water with very low TDS value. It is therefore no exaggeration to say that improvement in existing Water Treatment Plants, and provision of better quality water to the citizens can help optimize Delhi’s water demand and also reduce the waste water load of River Yamuna. At the same time, there is a need to initiate further research on studying the impact of continuous consumption of water with very low (5-15 mg/l) TDS on human health.

The health risks from drinking demineralized (or water with very low TDS) are now fully known in the present day (Kozisek, 2005). While some scientists believe our body can obtain some minerals from water only, others are of the opinion that lack of any minerals in drinking water can be accommodated through having a balanced diet (Pelican News, 2016). A consensus needs to be built on this before a policy decision in this direction can be taken. At the same time, there is a need to carry out detailed investigation of the reasons behind high TDS values in the municipal water supply in Delhi on some days. Water samples need to be regularly analyzed to ensure that high TDS values are not because of a toxic substance that has somehow entered the water supply system. The apathy shown by the residents of Delhi towards public water distribution outside their households is equally concerning. The Government of NCT of Delhi needs to take urgent measures for restoring the faith of the people of Delhi in the municipal water supply. This is also needed to be done since in the absence of such faith, the residents of Delhi are fully capable of exploring private acquisition of water using bore wells, etc. Indeed, greater dependency of residents on ground water is not healthy due to polluted ground water in various parts of Delhi (Singh, 2012).

Since the R.O. devices will only gain more popularity in coming years, the Government and citizens need to take innovative steps in ensuring that the R.O. reject water is reused perhaps for cleaning or other non-drinking purposes. The study clearly shows that the TDS value of reject water from R.O. devices is also mostly within the desirable value (500.0 mg/l) of TDS. While the reasons (chemical species) of high TDS are not known (since the original source of water is municipal supply, the reject water should not have any toxic substances under ideal

conditions), this water may not be used for drinking but is safe for any other use. Citizens should therefore take proactive measures, and Government should focus on formulating a policy at the residential area level such that the reject water from R.O. devices is reused/ recycled and is not directly sent to the sewer.

6. Conclusion

Drinking water supply in the NCT of Delhi is managed by the Delhi Jal Board under the Government of NCT of Delhi. Although the water supply in Delhi seems to be state controlled, there is considerable micro-scale privatization of water in the city. A principal reason behind this is the lack of consistent supply of drinking water from the DJB. The fluctuating TDS of municipal water supplied to the residents of Delhi needs immediate Government attention. Citizens must be provided clean drinking water consistently, lest it will promote further penetration of R.O. devices which come with their inherent shortcomings. Large-scale use of R.O. devices not only increase Delhi’s water footprint but also its electricity demand. This Water-Energy Nexus needs further investigation.

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A Wetland and a Lifeline: the Importance of Loktak Lake for Manipur, India

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Abstract: Wetlands are highly productive ecosystems which provide multiple-value ecosystem services. The Loktak Lake wetland is located in the Bishnupur district of the Indian state of Manipur, and is the largest freshwater wetland in Northeast India. The lake is used extensively by local people as a source of water for irrigation and domestic use and is an important wintering and staging area for water birds, particularly ducks. The Loktak Lake has a socioeconomic and cultural relationship with the people of Manipur. However, of late, the impacts of increase in population, urbanisation and the rapid pace of development have started being felt on Loktak Lake. The once over 266 sq. km large Loktak Lake is now showing signs of shrinking and reduction in wetland spread. The lake had a seasonal and pulsating characteristic which kept it clean and healthy. However, changes in its hydrology due to regulation of water flow for development purpose are now showing a detrimental effect on the health of this wetland. The following article is an attempt at putting greater focus on the lifeline of Manipur, the Loktak Lake and a floating island paradise where tourism is wanting.

Keywords: Loktak Lake, wetland, ecosystem services, Manipur.

1. Introduction

Loktak Lake is the largest freshwater wetland in Northeast (NE) India and was declared a wetland of international importance by the Ramsar Convention in the year 1990. Loktak Lake is considered the lifeline of Manipur and is an integral part of the socioeconomic and cultural life of the people in the state. It plays an important role in flood control as well. A characteristic feature of Loktak Lake are *phumdis* or the 'floating islands'. *Phumdis* are floating heterogeneous mass of entangled

vegetation, formed by the accumulation of organic debris and biomass with soil particles, which have been concentrated in solid form. Floating islands are a common phenomenon in lakes and wetlands around the world (Kaul and Zutshi, 1966; Trivedy et al., 1978; Sasser et al., 1995; Mallison et al., 2001) and are also known as tussocks (Hujik, 1994), floatons, floatant (Sasser and Gosselink, 1984) or suds (Alam et al. 1996; Haller, 1996). Floating islands are composed of native or exotic plants growing on a buoyant mat consisting of plant roots and organic matter (detritus). This definition of floating islands includes small (less than 0.01 ha) free-floating islands and extensive, stationary, vegetated mats which may cover hundreds of hectares of water (Mallison et al., 2001). *Phumdis* of Loktak Lake are basically heterogeneous mass of soil, vegetation and organic matter at various stages of decomposition (Trisal and Manihar, 2002). The *phumdis* occur in different sizes and thickness and in the natural state, occupy almost half of the wetland area. The southern part of Loktak Lake wetland forms the Keibul Lamjao National Park, which is the one of the largest 'floating island' wildlife protected areas in the world. It is composed of a continuous mass of floating *phumdis* occupying an area of approx. 40 sq. km (Prasad and Chhabra, 2001).

Loktak Lake was indexed as a Ramsar site (Site No. 463) (Wetland of International Importance) on the 23rd of March, 1990 (Ramsar, 2012). Loktak Lake has also been added to the Montreux Record since 16th June 1993. The Montreux Record is a register of wetland sites on the list of wetlands of international importance where changes in ecological character have occurred, are occurring, or are likely to occur as a result of technological developments, pollution or other human interference (Ramsar, 2012). Loktak Lake wetland was added in the Montreux Record largely because of the ecological problems it faces such as deforestation in the catchment area, infestation of water hyacinth and pollution. According to the Ramsar listing,

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the construction of the Ithai barrage (in 1979) at one end of the Loktak Lake, largely for hydroelectric power generation and irrigation purposes, has caused the local extinction of several native fish species.

The Loktak Lake is an important source of water, fisheries and vegetation providing sustenance to a large population dependent upon lake resources for their sustenance. The lake water is used for irrigation, domestic purposes and power generation. The lake vegetation is harvested for use as food, fodder, fiber, fuel, handicrafts and medicinal purposes. The lake water is also used for power generation by the National Hydro Electric Power Corporation (NHPC) which has installed a hydroelectric power project with a total installed capacity of 105 MW (Trisal and Manihar, 2002).

The increase in population and greater dependency on Loktak Lake in recent years is deteriorating the ecological balance of the lake leading to a reduction in ecosystem services. There is no comprehensive seasonal assessment of the ecosystem services provided by Loktak Lake. The ecological and socio-economic significance of the *phumdis* does not form a part of contemporary management plan for Loktak Lake. At the same time, detailed investigation of human dependency on Loktak Lake is wanting and is required for developing a more inclusive management plan. There are no detailed studies of direct impact of Loktak Lake and its changing conditions on the neighbouring human populations. This article is therefore an attempt to collate the various benefits that are being obtained from the Loktak Lake and a forewarning that apathy and ignorance towards the now increasing pollution of Loktak Lake will only result in greater misery for the people of Manipur and Northeast India.

2. A Note on Wetlands

Wetlands are areas subject to permanent or periodic inundation or prolonged soil saturation sufficient for establishment of hydrophytes and/or the development of hydric soils. They are places where a recurrent excess of water imposes controlling influences on all biota (plants, animals and microbes) (Tiner, 1999). Cowardin (1979) defines wetlands as land where an excess of water is the dominant factor determining the nature of soil development and the types of animals and plant communities living at the soil surface and spanning a continuum of environments where terrestrial and aquatic systems integrate. Burton and Tiner (2009) have defined wetlands as lands that are either inundated by shallow water less than 2 m deep during low water events or have soils that are saturated long enough during the growing

season to become anoxic and support specialized wetland plants (hydrophytes). In addition to this, wetlands could be of marine or estuarine nature and even include lake and streams which are greater than 2 m deep. However, the latter is the case only when such wetlands support persistent emergent plant diversity (Burton and Tiner, 2009). Due to the regional differences in hydrologic regimes, climate, soil-forming processes and geomorphologic settings in areas marked by the aforementioned characteristics, a vast diversity of wetlands have evolved worldwide. Consequently, there is no single, indisputable and ecologically sound definition for wetlands, primarily because of the diversity of wetlands (Cowardin, 1979).

One of the most widely accepted definition of wetlands has been given by the Ramsar Convention on Wetlands of the International Union for the Conservation of Nature and Natural Resources (IUCN) (Lehner and Döll, 2004). The Ramsar Convention is an inter-governmental treaty that embodies the commitments of its member countries to maintain the ecological character of pre-defined 'Wetlands of International Importance' and to plan for sustainable use of the wetlands in the member countries' territories. The Convention and its underlying principles came into force in 1971 in the city of Ramsar in Iran. According to the Ramsar Convention, wetlands can be defined as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres" (Article 1.1). Also, wetlands "may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands" (Article 2.1) (Ramsar, 2012). It needs to be mentioned here that wetlands are known to be one of the most important and productive ecosystems in the world (Mitsch and Gosselink, 2000). They occur in all climatic zones, from boreal to tropical, and include bogs, fens, herbaceous marshes, woody swamps, shallow water bodies, riverine floodplains, and coastal beaches (Gopal and Ghosh, 2008).

The existence of the above mentioned large-scale diversity of wetlands necessitates the classification of wetlands into different types. Consequently, wetlands have been classified for various purposes by different authors from time to time. These classifications have been made largely for one or all of the following reasons: 1) to provide common terminology to describe similarities and differences among wetlands, (2) to group them for scientific studies and comparison, (3) to provide the

foundation for conducting wetland inventories that report on the status, trends, functions, and condition of wetlands in specific geographic areas, or (4) for their conservation, use, and management (Tiner, 1999). The underlying objective of all classification systems is to ensure effective and efficient natural resource management and conservation of wetlands. The criteria for wetlands classification systems developed for natural resource management is based on factors such as vegetation, hydrology, water chemistry, soils/substrate, and geomorphology. Some prominent wetlands classification schemes and approaches are the Ramsar multinational classification system, its regional modification for East Africa, wetland classifications from the United States, Canada, and New Zealand; a geomorphic approach to global wetland classification and a hydrogeomorphic approach used in the United States (Tiner, 1999). It needs to be noted here that two sets of environmental factors determine the principal types of wetlands. These are water regime and nutrient supply. The term “water regime” refers to hydrological factors including depth and duration of flooding while “nutrient supply” refers to chemical factors including available nitrogen, phosphorous and calcium (Keddy, 2010).

3. Appraisal of Natural Resources of Loktak Lake

Brühl and Biswas (1926) studied the algae of the Loktak Lake wetland while Biswas (1936) made an inventory of the diatoms of the Loktak Lake wetland. Chaudhuri and Benerjea (1965) have reported on the fisheries of Loktak Lake with special reference to the development of Takmu beel area of Loktak Lake for pisciculture. The fauna of the Loktak Lake has been reported by Annandale and Hora (1921). The 40.5 sq. km Keibul Lamjao National Park, which forms part of the Loktak Lake wetland is the last remaining natural habitat of the Manipuri brow-antlered deer (*Rucervus eldi eldi*) (Gee, 1960).

The phytosociology, primary production and nutrient status of the macrophytes of Loktak Lake have been investigated in great detail by Devi (1993). Santosh and Bidan (2002) studied the distribution of aquatic vegetation of Loktak Lake. The characteristics and classification of soils in the Loktak Catchment Area was carried out by Sarkar et al. (2002). The soils in this area were found to be deep, moderate to slightly acidic (pH 4.6–5.4) in the surface, rich in organic carbon, low to medium in exchange capacities with higher clay and low base status in the subsurface horizon. Soils were high in available nitrogen, medium to high in available potassium and low in available phosphorus. Available iron and manganese were high, Cu and Zn were low particularly in subsurface horizon (Sarkar et al., 2002). The habitat

heterogeneity of the Loktak Lake wetland has been reported by Sanjit et al. (2005) with a special focus on avifauna.

The actinomycetes in the Loktak Lake wetland were isolated and screened for antimicrobial activities by Singh et al. (2006). A total of 37 actinomycetes with distinct characteristics were isolated from the soil samples collected from the *phumdis* in the Loktak Lake. 12 of these isolates (which belonged to genus *Streptomyces*) were found to have broad spectrum of activity against the tested microorganisms which underlines the potential of the *phumdis* of the Loktak Lake as a source of novel antibiotics (Singh et al., 2006). Ningombam and Bordoloi (2008) conducted a survey of the amphibian diversity of Loktak Lake wetland and checked the inventory with the conservation status of individual species. They have reported a total of 25 different species of amphibians belonging to 7 families. Some rare frogs belonging to the Megophryidae family have also been reported in the Loktak Lake (Ningombam and Bordoloi, 2007). The rotifers of Loktak Lake wetland were extensively studied by Sharma (2009).

4. Anthropogenic Dependency on Loktak Lake

Leima et al. (2008) studied the dependency of lakeshore communities for livelihood (especially aquatic vegetation) on the floating islands of Keibul Lamjao National Park. The socioeconomic conditions of residents of six villages located in close proximity to the National Park were analyzed using appropriate survey methodology. The villages selected are Thanga Salam, Sagram, Keibul Mayai Leikei, Wapokpi, Nongmaikhong and Khordak. They found that aquatic vegetation collection from the Park alone contributes as high as 89.70% of the average annual household income in Keibul Mayai Leikei village (with 111 number of households) while fishing in and around the Park contributes 67.2% of the average annual income in Thanga Salam village (with 116 number of households) (Leima et al., 2008).

They have also documented the collection pattern of non-wood forest products for livelihood generation by the lakeshore communities residing around the Keibul Lamjao National Park. Sunanda et al. (2014) carried out an assessment of the Sustainable Livelihoods of Loktak Lake Islanders in Bishnupur District of Manipur. They found that majority of the Islanders had medium level of livelihood on different aspects of sustainability factors. Indeed further, and more comprehensive studies are required to establish the resource dependency of the people living around the Loktak Lake on its resources.

5. Sustainable Management Challenges

The Loktak Development Authority (A Government of India undertaking) has analysed the ecological and socio-economic features of the Loktak Lake wetland. The analysis was based on a holistic study of the integrated catchment as well as institutional arrangement to deduce the following key issues in the conservation and management of Loktak Lake wetland (LDA, 2011):

- Enhanced soil erosion leading to wetland sedimentation due to shifting cultivation and loss of vegetal cover in the catchment area
- Reduction in water holding capacity of wetlands as a consequence of siltation, encroachments, and prolific growth of aquatic vegetation
- Flooding in peripheral areas leading to inundation of agricultural areas and damage to life and property
- Deterioration of water quality due to inflow of sewage from urbanized and peripheral areas
- Decline in fish resources thereby affecting the livelihoods of the fisher communities
- Degradation of *phumdis* in KINP affecting the biodiversity of the national park particularly the flagship species, *Rucervus eldi eldi*
- Poverty due to resource degradation and limited opportunities of livelihood diversification.

The impacts of climate change upon river discharge within three sub-catchments of Loktak Lake wetland was carried out by Singh et al. (2010). Two groups of climate change scenarios are investigated by them. Group 1 uses results from seven different Global Climate Models (GCMs) for an increase in global mean temperature of 2°C, the purported threshold of “dangerous” climate change. Group 2 is based on results for increases in global mean temperature between 1°C and 6°C. Results from the Group 1 scenarios show varying responses between the three sub-catchments. The majority of scenario-sub-catchment combinations indicate increases in discharge will vary from <1% to 42%. Six of the GCMs suggest overall increases in river flow to Loktak Lake (2–27%) whilst the other results in a modest (6%) decline. In contrast, Group 2 scenarios lead to an almost linear increase in total river flow to Loktak Lake with increasing temperature (up to 27% for 6°C), although two sub-catchments are modeled to experience reductions in mean discharge for the smallest temperature increases.

Further, they have noted that although elevated water levels may permit enhanced abstraction for irrigation and domestic uses, future increases in hydropower generation are limited by existing infrastructure (Singh et al, 2010).

They also warn that higher water levels in the Loktak Lake wetland in the near future are likely to exacerbate existing ecological deterioration as well as enhance problems of flooding of lakeside communities.

Since the construction of the Ithai barrage in 1979, the water levels in the Loktak Lake have been constantly regulated to maintain the generation of hydropower. High water levels in the Loktak Lake have impacted the ecological conditions of the wetland, and the floating vegetated islands (*phumdis*) are the worst affected (Singh et al., 2011). Singh et al. (2011) have put forward an integrated solution to this problem by recommending the balancing of hydropower and agricultural abstractions of water with respect to optimizing wetland water-level requirements. The effects on the fluvial system of Loktak Lake sub-basin due to the bi-directional inter-exchange of flows between the Loktak Lake wetland and the Manipur River have been studied by Singh et al. (2008). The flow in two inter-linking channels, viz. Khordak and Ungamel, is examined with a modeling approach. They report that silt transport dominates the fluvial entity of Loktak Lake by more than 80% (relative to clay and sand) in exchange of flows with the main drainage river in the basin.

The pollution status and aquatic bio-resources of the Moirang River near its mouth in the Loktak Lake was evaluated by Kosygin et al. (2007). The river water was found to be polluted noting high concentration of free CO₂ (14.8 mg/l), nitrite-nitrogen (0.040 mg/l), inorganic phosphorus (0.107 mg/l) and faecal coliform bacteria (162 /100 ml). Aquatic bio-resources of the river included 24 species of fish representing 20 genera of 13 families and 16 species of macrophytes representing 14 genera of 9 families (Kosygin et al., 2007).

Banerjee et al. (1983) carried out a comparison of seasonal and diurnal patterns of some physico-chemical parameters of the open and closed parts of Loktak Lake to investigate the impact of human activities on these variations. The study was carried out from 1976 to 1978. They found that the closed part of the lake, used for controlled fishing, was well protected while the open part was subject to considerable human activities. Simultaneously, they found that the variation in the physico-chemical parameters in the open lake were different from those of the closed lake in that (a) there was distinct seasonal variation in dissolved oxygen which was not evident in the closed lake and (b) there was direct relationship between diurnal variation of CO₂ and pH instead of an indirect relationship in the closed lake. A similar pattern was found in the case of pH, electrical conductivity, bicarbonate, free carbon dioxide and

chloride thus indicating significant impact of human activity on the Loktak Lake wetland (Banerjee et al., 1983).

Singh and Khundrakpam (2009) carried out a case study of the phumdi proliferation in the Loktak Lake wetland. The study was based on remotely sensed data of 1989 and 2002 and field surveys covering eight villages and 377 households. Their results showed that the phumdi area has increased from 1989 to 2002 and the main causes for phumdi proliferation are the construction of the Ithai Barrage Dam, increase in athaphum fishing, pollution and growth of settlements on phumdis. Thus, the growth of phumdis is largely a result of the demographic pressure on the Loktak Lake wetland (Singh and Khundrakpam, 2009). The impacts of high water level in the Loktak Lake wetland throughout the year due to the Ithai barrage and the need to regulate such a high intensity of man-made intervention has been discussed by Singh (2010).

The major and trace elements in the water samples of Loktak lake and Nambul River, the most polluted river draining into the Loktak Lake were determined by using Energy Dispersive X-ray Fluorescence (EDXRF) technique by Singh et al. (2013). They found that despite the polluted Nambul River drains into the Loktak Lake, the concentration of some toxic elements are within the permissible level in the Lake (Singh et al., 2013). The Loktak Lake thus has been able to buffer against the increasing pollution and large-scale degradation taking place around it. However, this may not be the case for long and concerted steps and urgent measures need to be taken today for protecting and preserving the Loktak Lake and its natural resources.

6. Conclusion

The Loktak Lake is an important wetland for the people of Manipur and as is the case with other natural resources, Loktak Lake is also witnessing the increasing pressure of rising population and unplanned developmental activities. Indiscriminate removal of *phumdis* is being done in the Loktak Lake without understanding the ecological or social relevance of these masses of vegetation. A sustainable amount of *phumdis* should always be left to sustain the needs of the local communities and ensure the ecological functioning of the Lake. Studies have shown that *phumdis* can be utilized for conversion to fuel and compost (Devi et.al, 2002; Meitei and Prasad, 2012; Singh and Kalamdhad, 2014). This can be explored to maximise the utilisation of the unique phumdis. A natural resource management solution has to be promoted which will improve the sustainability of the Loktak Lake and which would enhance the sustainable livelihood of the

local communities. This can be possible only when all stakeholders are involved in the management process. A viable combination of the traditional knowledge of the local communities and the scientific knowledge of the Manipur administration is the only way forward for sustainable management and development of Loktak Lake.

7. References

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Food in the City: Review of Psychological Impact of Growing Food in Urban Spaces

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Abstract: The activity of growing food is an integral part of human civilization and survival. The present paper attempts at exploring the psychological impact of growing edible greens in the context of urban environment. The review focuses on the impact of growing food, with primary focus on psychological impact and mental health. The findings indicate an encouraging trend in urban farming, though research activity and academic interest in the area of psychological impact of growing food seems limited. Additionally, the review throws light on the sparse research in developing countries on the said topic.

Keywords: urban farming, psychological impact, mental health.

1. Introduction

Contact with nature in its numerous forms - through viewing landscapes that have an abundance of vegetation (Ward Thompson, 2011; Velarde et al., 2007), by being close to a lake (Song, 2015), by spending time walking on beautiful sandy beaches, by growing flowers in the balcony - ameliorates stress and has health benefits. This belief has a rich, long history. It goes back to Cyprus the Great, who - some 2,500 years ago - built gardens for relaxation in the busy town of Persia. Paracelsus, the 16th century German-Swiss physician, gave voice to the same when he wrote, "The art of healing comes from nature, not from the physician." In the Republic of Ireland, care was given to 'troubled people' by monks way back in the 14th century, through their involvement in monastery gardens. The Friends' Hospital in Philadelphia, USA, first opened a horticultural therapeutic unit in 1817, which is still running. In the UK, by the mid nineteenth century, local authorities were noticing that the well-being of patients involved in gardening work in the grounds was

better than that of their co-residents who were incarcerated indoors, largely in seclusion and looked after by servants. This led to the Dorset County Asylum regulations in 1856 actually making it obligatory for inmates to be involved in outdoor work (Ryan, 1993).

We have long believed, experienced and lived the many restorative effects of living close to nature. In India, there are festivities to mark the sowing as well as harvest seasons, most of which are celebrated in the fields symbolizing peoples' intimacy with nature (Shiva, 1993). The increasing urbanization is leading to a systematic reduction of the natural, green, forest cover and is also creating a greater physical distance between man and nature. Numerous researchers have asserted that separation from nature is detrimental to human development, health and well-being (Stilgoe, 2001). Urban environments are seen as inducing stress, too much artificial stimulation and lack of exposure to natural environments, such as parks, can cause exhaustion and reduce vitality (Stilgoe, 2001). On the other hand, interacting with nature has been proven to be beneficial for human health. There have been noted numerous positive physiological effects that occur when humans encounter, observe or otherwise positively interact with animals, plants, landscapes or wilderness. (Ulrich et al. 1991).

2. Theoretical Perspectives on Mental Health and Contact with Nature

The impact of contact with nature can be understood from various perspectives. The first section of the paper explores briefly, some theoretical positions regarding the impact of nature, specifically impact of active involvement with nature, on mental health. The Biophilia Hypothesis was originally referred to as an 'innate tendency to focus on life and lifelike processes' (Wilson, 1984), meaning that we gain the most satisfaction from processes that mimic the nature of life on many levels, be

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they cognitive or emotional. The hypothesis revolves around the concept that people possess an inherent inclination to affiliate with natural processes and diversity, and this affinity continues to be instrumental in humans' physical and mental development. Burls (2007) highlighted the benefits of human-nature interaction in terms of nine values as follows: a) Aesthetic Value (physical attraction and beauty of nature): adaptability, awareness, harmony, balance, curiosity, creativity and an antidote to pressures of modern living. b) Dominionistic value (mastery and control of nature): coping and mastering adversity, capacity to resolve unexpected problems, leading to self-esteem. c) Humanistic Value (affection and emotional attachment to nature): fondness and attachment, connection and relationship, cooperation, sociability and ability to develop alliances. d) Moralistic Value (Spiritual and ethical importance of nature): understanding the relationship between human wholeness and the integrity of the natural world, leading to a sense of harmony and logic. e) Naturalistic Value (immersion and direct involvement with nature): immersion in the sense of authenticity of natural rhythms and systems, leading to mental acuity and physical fitness. f) Negitavistic value (fear and aversion of nature): developing a healthy respect for risk, powers and dangers inherent in nature with an equal sense of awe, reverence and wonder, leading to deal with fears and apprehensions in a constructive way. g) Scientific value (knowledge and understanding of nature): developing a cognitive capacity for critical thinking, analytical abilities and problem solving skills, leading to competence. h) Symbolic value (metaphorical and figurative significance of nature): being able to access the limitless opportunities offered by the processes in the natural world to develop understanding of one's circumstances, leading to cognitive growth and adaptability. i) Utilitarian value (material and practical importance of nature): emphasizing the practical and material importance of the natural world upon which we rely for survival.

There is support for the Biophillic hypothesis in the fact that this sort of attunement with nature has survival value. Additionally, it implies that people feel most comfortable in settings where they can identify with life processes (Gullone, 2000). The other theoretical postulations include, the need hierarchy model that draws upon Maslow's (1970) hierarchy of needs model. Townsend and Ebden (2006) created an intervention framework titled, 'Feel blue, touch green' wherein individuals suffering from mood disorders were given made to directly interact with natural environments, through which higher order needs were met. Also, an interesting observation of Maslow's description of 'peak'

experiences is that it often occurs in natural settings. The Environmental self-regulation hypothesis in the current context implies that physical activity in natural settings improves positive emotions, self-esteem and behaviours (Boldeman et al., 2004). This implies that natural settings have the power to offset negative emotional states and help in augmenting positivity.

The present paper attempts to take the discourse further and attempts at exploring the psychological impact of growing edible greens in the context of urban environment. The paper reviews the impact of growing food, with primary focus on psychological impact and mental health. The psychological impact of growing greens has further been thematically presented to facilitate clear conceptualization and understanding. Understanding food production in urban spaces in itself can be challenging owing to the activity not being entirely organized, by its dynamic nature and the fact that the land and resource use in urban farming is always clearly identifiable or quantifiable. A working definition of Growing Food could be understood as involvement in the process of sowing, nurturing, harvesting and facilitating the activities of growing edible plants; for the purpose of the current paper the activity of growing food has been concentrated to the urban areas.

3. Understanding Prevalence

Growing food for personal and family consumption is a significant global activity that has received insufficient academic attention (Church et al., 2015). People grow, or could grow, their own food for personal consumption in many and diverse settings such as allotments, balconies, community gardens, fire escapes, indoor surfaces, pots on patios, private gardens, rooftops and school gardens (Grewal and Grewal, 2012; Kortright and Wakefield, 2011). In an extensive review of domestic gardens in Europe, Church et al. (2015) made some interesting observations. In the UK, it is estimated that 87% of households have access to a private garden (Davies et al., 2009), although individual gardens are becoming smaller and there has been a tendency to pave over front garden plots, reducing actual or potential food growing space (Freeman et al., 2012). The decline in the proportion of garden owners who grow vegetables, from 35% in 1986 to 20% in 1996 may be associated with this reduction in available growing space. However, a Canadian study based on semi-structured interviews with people who grow their own food (Kortright and Wakefield, 2011) noted that "more garden space does not necessarily lead to more food growing some of the largest supported the smallest amounts of food". Rather than access to growing space, therefore, the authors concluded that the principal

barriers to food growing were necessary skills and time. Although far less substantial than private gardens in number and area, allotment gardens are also significant, numbering around three million in Europe (Barthel et al., 2010). Another extensive review has been compiled by Golden in 2013 focusing on the impacts of Urban Agriculture (Golden, 2013). The review is situated in America and focuses primarily on American data and academic work in the field.

There is evidence to suggest that demand for community gardens may be increasing in the UK and Ireland, with a 65% increase in the number of these gardens registered by the Federation of Urban Farms and Community Gardens in 2011 compared to 2010 (Clavin, 2011). How many of these are used for food production is not clear but, as a comparator, Taylor and Lovell (2012) found that only 13% of community gardens in Chicago were being used for food production. In an interesting book on domestic food production in Australia, the author notes that home food production in the 1990s was more common than it seemed (Gaynor, 2005) and also mentions a 1941 "Melbourne University Social Survey" saying that "48% of sampled households produced food of some kind". There is extremely limited information currently available on urban domestic gardens outside of cities in the west. Urban food production is central to the existence of many poorer cities across the globe (Ellis and Sunberg, 1998; FAO, 1998; Tewari, 2000; Bakker et al., 2001), but academic interest still remains scanty. In a study done on the composition, diversity, density and distribution of plant vegetation in urban domestic gardens in the rapidly expanding south Indian city of Bangalore, researchers found high proportion of species had uses as food or as spices, medicinal properties, and/ or religious significance (Jaganmohan et al., 2012). In many metropolises like Delhi, Mumbai, Hyderabad and Chennai or small cities like Nashik and Nagpur, people are forming gardening groups to learn from each other. The movement has caught on well in Bengaluru, which has an estimated 7,000 terrace or rooftop gardens (Pallavi, 2014). The available literature surely points to an encouraging food production trend in urban areas world-wide.

Gardeners appear to be aware that gardening is good for their mental health; in a study based in USA, gardeners involved with the Philadelphia Gardening Programme were asked why they gardened (Blair et al., 1991). Interviewing a total of 144 gardeners, Blair et al. found that recreation (21%) was the most important reason followed by health benefits including 'mental health' (19%), 'physical health and exercise' (17%) and 'produce quality and nutrition' (14%). A similar study in Toronto,

Canada (Wakefield et al., 2007) collected data on the perceived health impacts of community gardening through participant observation, focus groups and in-depth interviews. Results suggest that community gardens were perceived by gardeners to provide numerous health benefits, including improved access to food, improved nutrition, increased physical activity and improved mental health. Community gardens were also seen to promote social health and community cohesion.

4. Physical Health Impact

Physical health and psychological well-being are intrinsically related to one another. The two areas in which physical benefits of growing food can be studied are - at the level of consumption and at the level of exercise. Gardening not only facilitates the consumption of superior quality, fresh food but also increases the likelihood of consumption of fruits and vegetables. In a survey conducted on 799 adults in Michigan it was found that adults with a household member who participated in a community food garden consumed fruits and vegetables 1.4 more times per day than those who did not participate, and they were 3.5 times more likely to consume fruits and vegetables at least 5 times daily (Alaimo et al., 2008). Gardening helps in health promotion (Armstrong, 2000). The act of gardening requires physical strength, endurance and flexibility. Since it is an outdoor activity it also facilitates the intake of fresh air and Vitamin D. The Centre for Disease Control and Prevention considers gardening a moderate intensity level activity, and can help achieve that 2.5 hour goal each week, that can aid in reducing the risk for obesity, high blood pressure, type 2 diabetes, osteoporosis, heart disease, stroke, depression, colon cancer and premature death (State, 2014). Additionally, those who choose gardening as their moderate-intensity exercise are more likely to exercise 40-50 minutes longer on average than those who choose activities like walking or biking.

5. Stress Management

Growing plants - tending and nurturing a live space has understood to promote stress relief. There is a lack of direct research material on the psychological impact of food growing on stress. Gardening has also emerged, in the recent years, as a scientifically proven stress reliever. Stress can cause irritability, headaches, stomach aches, heart attacks and worsen pre-existing conditions in the body. An experiment published in the Journal of Health Psychology compared gardening to reading as a stress-relieving activity; test subjects that gardened experienced a more significant decrease in stress when compared to the subjects that were assigned to read (Van Den Berg and Custers, 2010). Research carried out in Sweden found that

people with access to a garden had significantly fewer stress occasions per year (Stigsdotter and Grahn, 2011). They reported that people living in apartment blocks with no balcony or outdoor area had an average of 193 stress occasions per year. This was reduced to 126 stress occasions if respondents had a balcony. Those with a small garden had 86 stress occasions, while the least stress was reported by those with a large leafy garden, who only reported an average of 65 stress occasions per year. They also found that the more often people used their gardens, the fewer stress occasions they suffered per year. In comparing gardens with other urban green spaces, they found that while both were important for health, having a private garden was more important.

Hawkins et al. (2013) found a significant difference in perceived stress levels between the activities groups of 'indoor exercise', 'walkers', 'allotment gardeners', and 'home gardeners'. Allotment gardeners reported significantly less perceived stress than participants of indoor exercise. In a second study, Hawkins et al. (2013) had an older adult sample of community allotment gardening with a particular emphasis on stress recovery and again results indicate that allotment gardeners appreciate both 'doing' the gardening as well as 'being' in the garden/ allotment landscape with a wide range of benefits to their health and wellbeing.

Gardening can thus be recognized as an important way of dealing with stress. For some gardeners, food growing is valuable time to be with friends and escape personal and work problems. For others, the opportunity to be alone, in an alive space, is often an essential way of coping with the pressures of daily life in a complex society.

6. Treatment of Specific Psychological Disorders

Research focus on specific psychological disorders and their treatment using nature, natural settings and involvement in greening and growing activities is recent and limited.

Attention Deficit Disorder: A study focusing on children with Attention Deficit Disorder (ADD) examined the relationship between children's nature exposure through leisure activities and their attentional functioning using both within and between-subjects comparisons (Taylor et al., 2001). Parents were surveyed regarding their child's attentional functioning after activities in several settings. Results indicate that children function better than usual after activities in green settings and that the "greener" a child's play area, the less severe his or her attention deficit symptoms. The study concluded that contact with nature

may support attentional functioning in a population of children who desperately need attentional support.

A number of studies have shown the benefits of horticultural activities for patients with dementia. In a review of the literature of the evidence to support the use of therapeutic gardens for the elderly, Detweiler et al. (2012) concluded that many preliminary studies have reported benefits of horticultural therapy and garden settings in reduction of pain, improvement in attention, lessening of stress, modulation of agitation, lowering of medications and antipsychotics and reduction in falls. Gigliotti and Jarrot (2005) studied whether planting, cooking or craft activities engender differential responses from adult day service participants with dementia, and in a later study the same author team (Jarrot and Gigliotti, 2010) evaluated responses to horticultural based activities for randomly assigned groups in eight care homes and compared with responses to traditional activities. They showed that horticultural activities reached groups of participants who would often be difficult to engage in activities and resulted in higher levels of adaptive behaviour and in active and passive engagement.

Luk et al. (2011), studying horticultural activities in a nursing home in Hong Kong, found no significant effect on the reduction of agitation among the home residents with dementia. However, a significant decrease in aggressive behaviour was noticed. Hewitt et al. (2013) evaluated the impact of therapeutic gardening for people with young-onset dementia, measuring outcomes for both participants with dementia and their careers. The conclusion from their preliminary study suggested that structured gardening over a 12 months period had a positive impact on the wellbeing, cognition and mood of people with young-onset dementia. Specific attention was drawn to the relationship between the wellbeing of participants and their cognition as the results of the study suggested that wellbeing can be maintained despite the presence of a cognitive deterioration. Self-identity and purposeful activity were reported as common themes as benefits of the gardening group, participants felt useful and valued and had a sense of achievement.

7. Impact on Specific Populations

Results of a web-based study that covered 1,28,836 children (youth under 18 years old) involved in gardening, primarily with teachers in school gardens, where children involved were generally 12 years of age or under and were growing food crops showed that adults gardening with children reported benefits to children's self-esteem and reduction in stress levels (Waliczek et al., 2000). Many schools are including growing food as an

important addition to the curriculum. Miller (2007) has suggested that when young children are participating in garden activities, they are: (1) communicating their knowledge about the world to others, (2) conveying (and learning to process and manage) emotions, and (3) developing important skills (e.g., initiative, self-confidence, literacy, math, science skills) that will help them be more successful in school and better navigate the world.

Geriatric population and gardening is growing food in an area where the elderly are often more skilled than younger people. Wang and MacMillan (2013) reviewed 22 articles that assessed the benefits of gardening for both community-dwelling and institutionalized older adults. Through various research designs (quantitative and qualitative) and measurements utilized, the results reveal that gardening can be an activity that promotes overall health and quality of life, physical strength, fitness and flexibility, cognitive ability, and socialization. The implementation of various aspects of gardening as health-promoting activities transcend contexts of practice and disciplines and can be used in urban and rural communities as both individual and group activities. Drawing from understanding from Erikson's (1985) Stages of Psychosocial Development, the stage of Generativity vs Stagnation (45 to 60 years) has particular importance. The act of growing food could be used as one of the engagements for healthy negotiation of this stage. Providing and working towards a larger meaning and goal aid in building self-reliance and self-esteem at this stage of life.

A research team from King's College, London, concluded that one of the most powerful factors in curbing crime and vandalism on problem housing estates was the presence of a garden (Lord, 1995). Schools have also reported a decrease in vandalism and an improvement in behaviour when children participate in greening the school grounds. Where primary prevention is too late, food growing can play a valuable role in helping to prevent reoffending. Few people realize that the prison service is already the third largest farmer in the country, and nearly self-sufficient in food. And although food growing is not seen, officially, as having a therapeutic role for many prisoners it undoubtedly does have one (Garnett et al., 1996). Given that 5,000 prisoners are referred for treatment of mental illness each year, there is real potential for linking up the farming work that prisons already do with the needs of the mentally ill. Food growing can also stimulate links between inmates and the community. Such activities help in the development of empathy and foster responsibility.

8. Social Interaction

Gardening appeals to people across demographic lines, community gardens can increase the interactions between people who would not normally meet or socialize. Older members of the community work alongside younger members, and all members can be welcoming to people across racial, religious, or ethnic boundaries (Bellows, 2003; Winne, 2008). These benefits have proven to be pervasive through time. Community gardens (Hou et al., 2009) are an important intervention to ensure social interaction and community building.

Many of the community food-growing projects in London have undoubtedly helped improve participants' quality of life, such as the Healing Gardens and Natural Growth projects which have enabled marginalised people to come together, develop skills, confidence and friendships (Garnett, 1999). The Dartford Road allotment site just beyond Greater London in Kent has grown into a hub of community activity. It is now so popular that there is a waiting list. Social events such as barbecues attract many people, and reciprocal arrangements such as bulk-buying and sharing manure are common (Dartford Roads Allotment Association, 1999). Many food growers, in turn, contribute directly to others in society and to the environment. Almost all community projects rely heavily on volunteers. Many allotment gardeners help each other with the work, or share produce.

9. Horticulture Therapy

The Horticulture therapy model refers to the use of plants and work in gardens to meet clinically defined goals. Research suggests that Horticulture therapy mediates emotional, cognitive and/ or sensory motor functional improvement, increased social participation, health, well-being and life satisfaction (Söderback et al., 2004). However, the effectiveness, especially of the interacting and acting forms, needs investigation. Growing food has the potential to be used in reformative spaces – it combines the important aspects of physical labour, community building and working, understanding of nurturance and patience, and an intrinsically built in reward system. In 1986/7, over 7,000 people with mental health problems were involved in horticulture. Gardening can be therapeutic for a number of reasons. Gardening therapy meets quite specific government criteria for mental health promotion (Mansell, 1993). These are:

- Community presence: Too often, mentally ill people are segregated, kept away from everyday settings. The advantage of many horticultural

projects is that they are in public places; a volunteer working on such a project in the middle of Battersea Park (Ryan, 1993) commented that after four years, he still had no idea what his fellow gardeners' difficulties were - if any. Such integration helps lessen the stigma attached to people who are 'different'.

- Community participation: Gardening requires some form of co-operation, while providing the opportunity for individuals to form more private friendships.
- Choice: Horticulture offers a choice of how to work - alone, with a friend, or as part of a team - and what to do. Even small decisions - such as what to plant, or where - can help people attain a sense of independence.
- Competence: The opportunity to perform meaningful activities leads to a sense of satisfaction and of self-worth. Gardening requires competence, in simple routines such as scattering seeds, or in complex tasks like pruning or plot design, as does cooking the produce grown. Indeed, many horticultural projects throughout the UK provide training for employment, both in sheltered and in commercial work places.
- Respect: Horticultural projects provide a situation where respect for self, others and all forms of life can be learned. The officer at the Battersea project above remarked that even those clients with a history of violent behaviour rarely act in this way in the garden.

10. Understandings and Implications

The present work is an attempt to understand the psychological impacts of growing food in urban spaces. The review facilitates some understandings and fosters curiosity on multiple levels.

1. Urban food growing is very much prevalent and is growing. This may be concluded from the various mentioned researches and the fast expanding informal gardeners' networks that are mushrooming in many metropolitans across the world.
2. There are numerous health benefits of growing food. Sustained research and academic interest will help uncover the many potential benefits urban farming has.
3. Agrarian countries like India and other developing nations, that are witnessing rapid urbanization, need be an important focus area. The interest, possibility and impact are bound to be manifold. The historical, cultural relevance and practice of agriculture, the spaces that have

been transformed from farm lands to urban dwellings and the collective psyche in which agriculture is integral component are all factors that make urban farming in developing countries enriching and essential.

4. Mainstream psychology needs to integrate the practice of growing foods and exploring its various benefits in obliterating stress and enhancing well-being. Varied methodologies such as case studies and experiments need to be conducted to better appreciate and understand the impacts of a long practiced healing activity.
5. Community gardening in educational institutes, parks and allotted spaces as well as private food growing initiatives should receive encouragement and support from the state.
6. Research and interdisciplinary academic collaborations will help augment the understanding of the psychological impact of growing food and provide it the much needed impetus and encouragement.

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SAR and Mobile Phone Radiation Hazard. How Aware are College Students in Delhi?

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Abstract: Mobile phones have become the most common gadget in the world today and are found in the hands of students most of the time. With advancement in mobile technology, usage of mobile phones has increased significantly. Mobile phone functioning uses electromagnetic radiation in the microwave range, which may be harmful to human health. Research has focused on this aspect since the invention of mobile phones and there seems to be a consensus that mobile phone radiations have an impact on human beings. However, no concrete scientific assessment of the impact of mobile phone radiation (MPR) on human beings has been made available. As a result, impact of MPR on human health is a research area requiring greater investigation. The following research contribution attempts to assess the awareness of undergraduate student community about radiation threat posed by the usage of mobile phones. We find that while students are concerned about various specifications of their mobile phones, the knowledge and awareness about MPRs is wanting.

Keywords: mobile phone radiation, human health, student community.

A mobile phone is a portable telephone that can make and receive calls over a radio frequency link while the user is moving within a telephone service area. Mobile phones have become a significant part of our daily life, especially for students for whom it is the key to their virtual world. Mobile phones operation requires electromagnetic radiations in the microwave range. The World Health Organization reviewed studies on mobile phone safety and has classified these radiations as "possibly carcinogenic to humans" (WHO, 2014). WHO places mobile phones in Group 2B, i.e. 'possible' human carcinogen. A categorization in 2B implies that there is convincing evidence that the agent causes cancer in

experimental animals but little or no information about whether it causes cancer in humans (IARC, 2015).

An overview of literature on the impact of mobile phone radiation (MPR) on human beings provides a confusing picture. Dreyer et al. (1999) have reported that exposure to MPR caused cultured human cells to shrink. However, AlOrainy (2003) found no association between brain tumour and MPR. Hardell (1999) found that exposure to MPR made a type of worm more fertile. These studies have indeed at least pointed out that exposure to heat is not the only potential threat to brain cells from mobile phones. Huber (2003) demonstrated that the exposure to Radio Frequency Electromagnetic Fields (RF EMF) emitted by mobile phones has an effect on brain physiology. In India, the Department of Telecom (Government of India) has been running a campaign to inform the citizens that, "most laboratory studies were unable to find a direct link between exposure to Radio Frequency radiation and (human) health" (DoT-GoI, 2012).

Although the debate whether MPRs cause cancer or not is far from over, its initial arguments are convincing enough to urge us to reduce our exposure to MPRs. An obvious way to accomplish this is by choosing a phone with a lower Specific Absorption Rate or SAR. SAR is a measure of the maximum energy absorbed by the unit mass of exposed tissue of a mobile phone user over a given time. SAR values are usually expressed in units of Watts per kilogram in either 1.0 g or 10.0 g of human tissue. The SAR standard value for mobile phones has been set to 1.6 Watts of energy absorbed per kilogram of body weight (1.6 W/Kg averaged over 1.0 g of human tissue). Because there is no conclusive evidence of the impact of MPR on human health (Jokela et al., 1999), the SAR limit has been set due to the thermal effects of MPR (any kind of RF radiation can heat up human body tissue considerably) and not to mitigate other radiation related impacts such as DNA damage or cancer.

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The following research contribution is an attempt to analyze the awareness of the student community in Delhi (India) on the issue of MPR and its health impact. Students are prominent mobile phone users and are thus exposed to MPRs greatly. An attempt was made to find out if this section of the society is aware of ongoing debate about MPR and its health impacts and also about regulations such as SAR which are in place. A survey sheet was prepared and 100 students randomly selected from various colleges of Delhi were surveyed during January-February 2017 on their mobile phone usage and awareness. The survey responses were then analysed to assess student awareness towards the health concerns related to their mobile phone usage.

The survey revealed that the most popular mobile brand in the sampled population is Samsung, followed by Xiaomi and Motorola (Fig. 1). Samsung J7 and Xiaomi's Redmi Note 3 were found to be the most popular models.

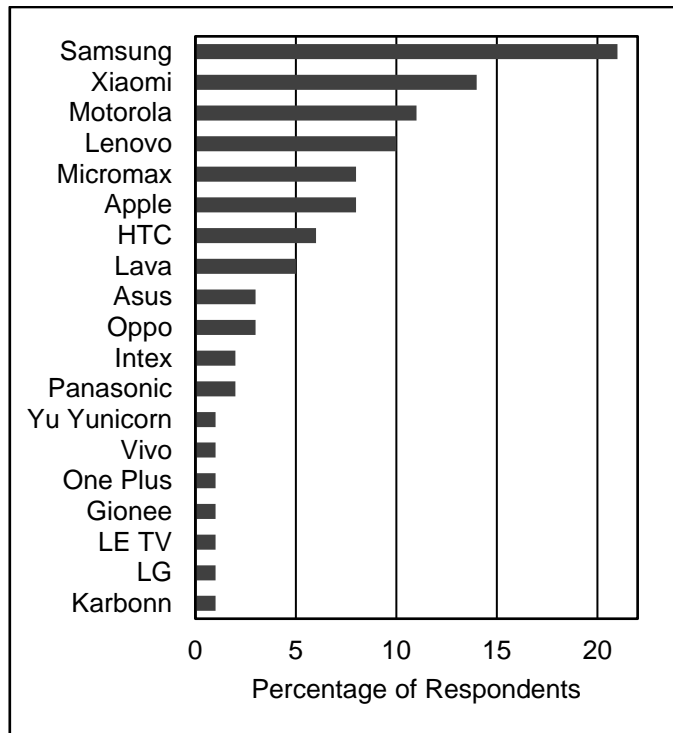


Figure 1. Popularity of mobile phone manufactures in the surveyed population.

According to the surveyed population, the most popular specification or feature of a mobile phone is camera. 36% of the respondents stated 'better camera' to be the reason why they bought the phone they are using. More 'powerful RAM' and 'cost effectiveness' were other top factors respondents considered before purchasing the phone they are currently using. 50% of the respondents

were found to have changed up to two phones, 45% were found to have changed up to 3-5 phones and 5% were found to have changed 6-8 phones since the purchase of their first mobile phone.

The survey revealed little awareness about the concept of SAR value in the respondents. 88% of the respondents were not aware of what is an SAR in terms of MPR and 89% of the respondents were not aware of any radiation limit (permissible value) that has been assigned for MPR (Fig. 2).

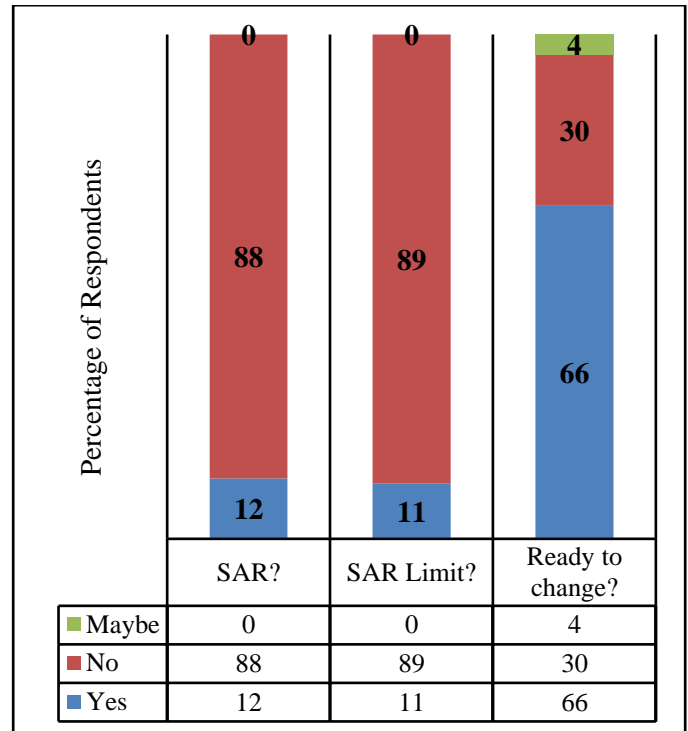


Figure 2. Awareness of respondents about SAR (SAR?), prescribe standard of SAR (SAR Limit?) and willingness to change mobile phone if it is found to emit high MPR (Ready to change?).

Interestingly, 66% of the respondents were found to be willing to change their mobile phone if they found that it is emitting radiations beyond the permissible value Fig. 2). 30% of the respondents, who did not show willingness to change their mobile phone in case it was emitting radiations beyond the permissible value cited additional financial cost to be the reason for their choice. One student in the surveyed population had changed the phone from a high SAR value phone to a lower SAR value phone, after becoming aware of the meaning of SAR.

The impact of MPR has to be directly proportional to the amount of time mobile phone users spend on the mobile

phone or the amount of time for which they keep it close to their body. Almost half the surveyed population was noted to be spending more than 16 hours per day with the mobile phone close to their bodies (Fig 3). Only 23% of the surveyed population reported spending less than 8 hours per day with their mobile phones.

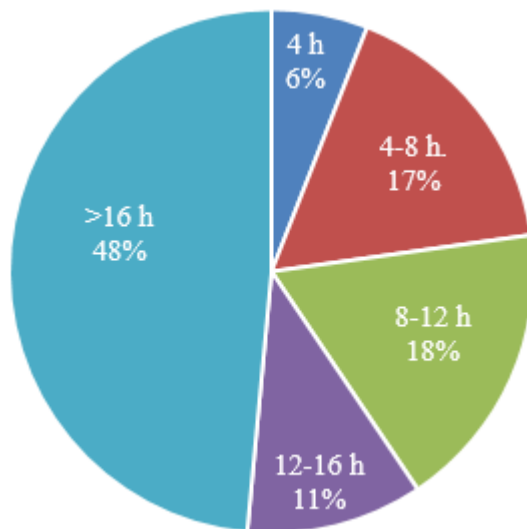


Figure 3. Duration in hours (h) spent with mobile phone close to the body.

Regulations notified by the Government of India require every mobile phone to display the SAR value of the model so the consumers can make an informed decision before each purchase (DoT-GoI, 2012). This information can be retrieved by dialing the following Unstructured Supplementary Service Data (USSD) code on individual mobile phone: *#07#. Some old mobile phone models do not have this code enabled.

The surveyed population carried new or (software) updated mobile phones and was asked to check their mobile phones SAR value using this USSD code. The USSD code was shared with those who were unaware about how to find the SAR value of their mobile phones. 68% of the sampled population was found to carry a mobile phone with SAR value less than 1.50 W/kg (Fig. 4). 4% of the mobile phones of the sampled population noted SAR value between 1.50 W/kg and 1.59 W/kg.

The permissible level for SAR in India is 1.60 W/kg. Interestingly, 28% of the mobile phones of the sampled population either did not respond to the *#07# USSD code or simply returned a message that the phone was complying to the SAR regulation (Fig. 4). All these mobile phones were either new or had their software

updated to the most recent version. The users of these mobile phones therefore cannot find out how exposed they are to MPR and if their mobile phone is compliant to the SAR standard value of 1.60 W/kg. They had also not checked while purchasing the mobile phone.

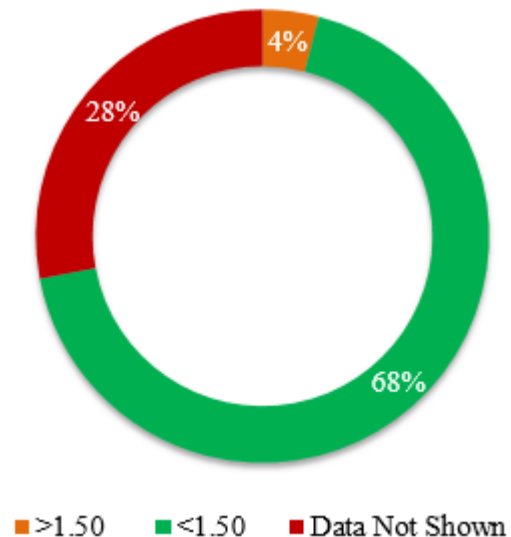


Figure 4. Real time SAR values of mobile phones being used by the surveyed population.

Mobile phones are a relatively recent phenomenon and research has only begun to find out the impact of consistent exposure to MPR on human health. Most research focuses on short-term impacts and for some obvious and not so obvious reasons, research on long-term impacts of MPR on human health is wanting. Some researchers have hinted that long-term use of mobile phones is bound to cause diseases such as Alzheimer's, migraine, infertility, cancer, eye defect, insomnia, depression, electromagnetic hypersensitivity and interface Maregu (2016). There is thus an urgent need to take the issue of MPR more seriously and establish any harmful effects it may have on human population in the long run.

There is also a need for creating awareness among the youth on MPR exposure and its regulation measures such as prescribed standard SAR values. This may be achieved through Government's intervention of disseminating relevant information through mass media. Parents also have a role to play in selecting a mobile phone for their children. Thus, such a media campaign should target all sections of the society. The Government also needs to ensure that every mobile phone company displays the SAR value of individual mobile phone models and rules may be framed for taking action against those mobile phone companies who are hiding this information.

Acknowledgement

The author would like to acknowledge the mentorship of Dr. Govind Singh from the Department of Environmental Studies, Indraprastha College for Women, University of Delhi for the ongoing research project with the same title.

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Exploring 100 Years of Bollywood's Infatuation with Birds

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Abstract: Bollywood is the popular name which encapsulates the Hindi film industry which is based in Mumbai in the Central Indian state of Maharashtra. Indian cinema, as is true for any other cinema in any other part of the world, is a reflection of the society it is located in. Film makers in Bollywood have always remained sensitive towards societal issues. At the same time, the films made in Bollywood have been such that the average Indian citizen can relate to them physically and/or emotionally. One theme that Bollywood has constantly explored and relied on is nature - flower and birds. The following paper attempts to analyze and explore the depiction of birds in Bollywood in the over 100 years long history of the latter. The paper also attempts to assess the changing trend in depiction of birds in Bollywood over this time period.

Keywords: Bollywood, birds, films, environmental awareness, human emotions.

Cinema in India is dominated by its Hindi speaking version, known as Bollywood. Indian cinema began much before the Independence of India (1947). The first feature film was shot by Dadasaheb Phalke in 1913 in Marathi, and was titled "Raja Harishchandra" (based on a Sanskrit script). First sound movie of Indian cinema was made by Ardeshir Irani in 1931, with the title "Alam Ara", a South India production. Films continued to be made before independence, though the Golden age of Indian cinema started only after India's independence. Thus, the Indian film industry has been a witness to over 100 years of history and transformation of India, right from 1913 till the present day. It is for this reasons that several researchers have used the depictions in Bollywood as a case study for addressing various research questions on the Indian society (Rao, 2007; Rajadhyaksha, 2009).

A characteristic feature of Bollywood, which sets it apart from certain other film industries, is the ubiquitous inclusion of songs in the films. The following research communication is an attempt to study the depiction of birds in the songs of Bollywood films over the last hundred years. The representation of birds is studied from the perspective of the species depicted and the expressions these depictions are used for. The Indian sub-continent has been home to a large number of birds since the very beginning (Ali and Ripley, 1990). Delhi, the National Capital Territory of India, itself boasts of being one of the most bird diversity rich capital city in the world. However, of late, unplanned urbanization and environmental pollution have led to the reduction in birds' number and diversity in Delhi. It is for this reason that sparrow, an otherwise commonly found bird, was declared the State Bird of Delhi in 2012. The research work therefore also attempts to explore the possibility of using film media as a tool for raising awareness for the conservation of avian diversity.

The research work was begun by making a database of all the songs which included the mentioning of birds in them. This was done by using the Internet as well as discussions with senior relatives. A total of 100 songs could be identified in this process. The songs were later searched on YouTube for further observation and the database was maintained. The database was then analyzed to check which bird species is being mentioned and what expression the depicted species depicts.

The rich avian biodiversity of India finds its mention in Indian cinema. Bollywood holds an important position in world cinema and has indeed provided adequate inclusion to India's bird diversity, which also has cultural relevance. At the very outset, the research finds that many of the films have titles which include names of birds or mention birds in general. Some of these are Hum Panchhi Ek Dal Ke (1957), Aas Ke Panchhi (1961), Pyase Panchhi

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(1961), Tota Maina Ki Kahani (1976) and Lafangey Parindey (2010). A detailed analysis of the 100 songs reveals that in addition to the generic word panchii (bird) in the songs, the most commonly used bird is the peafowl (Fig. 1). The peacock has been used in songs from the beginning, perhaps because of its beauty and size. This perhaps also explains the reason why the peacock was chosen to be the National Bird of India in the 1960s even when ornithologist Salim Ali had recommended the endangered Great Indian Bustard to be made the National Bird of India (Ali, 1962). The sparrow, koyal, bulbul and parakeets are other birds which find prominent mention in the Bollywood songs to depict various human emotions. Interestingly, the parakeet and the myna are often used together to depict a love-pair even when these two are two different species altogether.

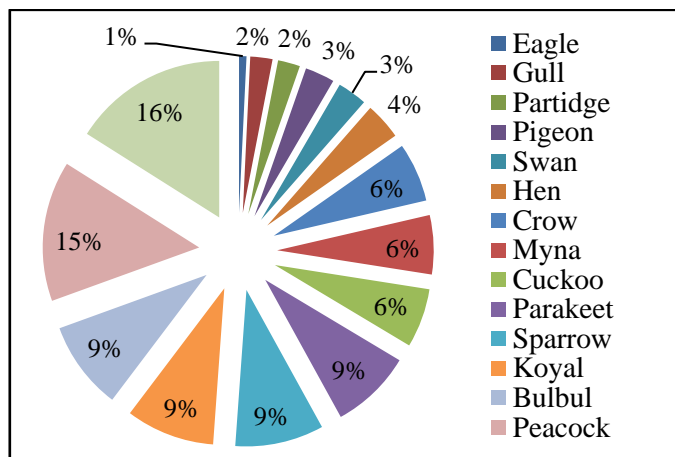


Figure 1. Percentage mention of different species of birds in Bollywood songs (Note that generic use of the word *panchhi/parindey* has been excluded).

Birds are generally personified as human beings and considered to express all the emotions of a human. There are a lot of poetries, dance forms, sketches, classical music and different cultural art forms in which birds are depicted as a creatures with emotions. A similar finding came forward from analyzing the songs database. Throughout the hundred years of its existence, birds have been significantly used in Bollywood songs to showcase various other emotions of human life including love, happiness, freedom, sadness, etc. The human emotion most widely exhibited using bird as a metaphor is that of love (Fig. 2). This is followed by happiness, freedom, sadness and beauty. Some of the songs do bring forward important and true attributes of birds. For example, the song 'Do Hanso Ka Joda' (1961), actually represents the life-long bonding of the male and female individuals of the Sarus crane (Hammer, 2009).

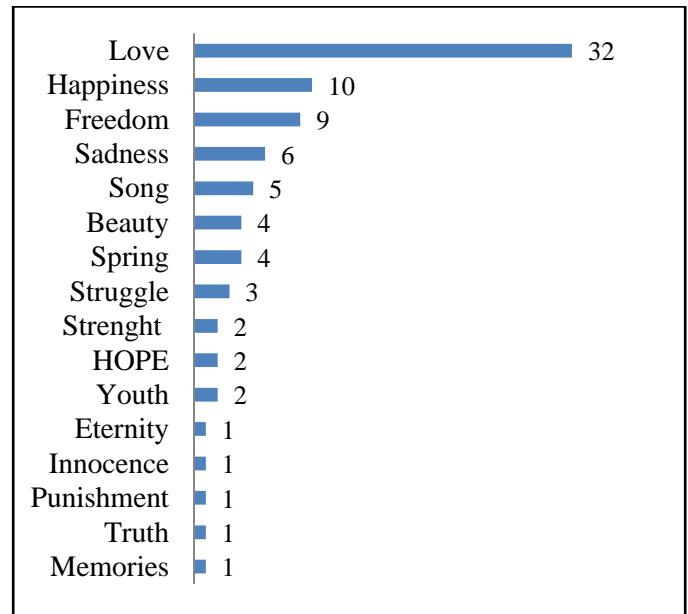


Figure 2. Percentage use of birds as metaphors for expressing different human emotions.

A great dance/ dancer is also often attributed to peacock or bulbul. Freedom is another human emotion which is often attributed to birds. The contribution of Bollywood in reminding the citizens about their natural heritage in terms of bird diversity cannot be ruled out. However, Bollywood has so far focused only on the more popular bird species most of which are not under threat of extinction. Bollywood can play a much more significant role in bird conservation if it can learn from local folklore and shift towards depicting endangered species of birds in some or the other form.

Acknowledgement

This research is part of Project Hornbill at Indraprastha College for Women and was mentored by Dr. Govind Singh and had 25 students as team members.

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English Versus Hindi and Other Regional Languages – A Survey Based Analysis

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Abstract: Language is not only a way to express or communicate but is also a heritage for a community which communicates in a particular language. Language also provides an identity to a person. Various emotions and sentiments of an individual can be best expressed in her/his mother tongue. Due to these reasons, language is always one of the dearest things for people, which civilizations have always strived to keep safe with them forever and also to pass on to the next generation. This paper attempts to study the status and appreciation of Hindi and other regional languages of India among the youth of the country.

Keywords: Hindi, India, national language, linguistic diversity.

India is a nation full of linguistic diversity. With the advent of British in the Indian sub-continent in the seventeenth century, the people of the sub-continent were introduced to English culture and language. Initially, the British came to the Indian sub-continent for trade, which perhaps motivated them to learn the native languages of India so they could communicate with native people of India. Some among the Indian sub-continent gradually acquired colloquial knowledge of English. These were called Indo-Britons who subsequently began communicating in English even in their day-to-day life. Except for the Indo-Britons, others native people of the Indian sub-continent seldom used English unless they had to communicate with the Europeans for purpose of trade, etc. A subsequent rapid increase of British domination over the Indian sub-continent made English a lucrative language to learn. Eventually, knowledge of English language became an indispensable qualification in the Indian sub-continent and also led to an increasing demand for English education (Allen, 1854). Due to the great linguistic diversity in Indian sub-continent, the British

continued to feel the need for having a common/ general language (Allen, 1854). The need for having a common/ general language for India continues to be felt even today. Considerable debates and arguments revolve around this issue creating much confusion and disarray. According to Rao (1978), Hindi could be the official language but written in both Devanagari and Roman scripts. Further, English could be the second official language to be used by non-Hindi speaking states, if desired, and Hindustani should be the oral communication link for the masses (Rao, 1978). On the contrary, according to Srivastava (2000), Hindi is merely a *Sanskritised* version of English and by submerging many other dialects in Hindi, it has become inevitably dependent on English (Srivastava, 2000). Mishra (1972) has raised clear opposition to English even being considered as an official language although its study may be continued (Mishra, 1972).

A constant emphasis on study and knowledge of English had been advocated by many scholars, even those who support other native languages. According to Orsini (1999), Hindi, 'the people's language', is the only one language fit for the mass education (Orsini, 1999). On the other hand, Dutt et al. (1985) have been of the view that Hindi is incompetent at higher level of education and it has to become more liberal in order to prepare for its wider role. Schools and Universities in India should therefore nurture Hindi and it should be enriched by assimilation of vocabulary and styles from other regional languages mentioned in the eighth schedule of the Constitution of India (Datt, 1968). The present research contribution explores the historical debates revolving around language discourse in India amidst the emergence of an alien language appearing in the scenario. The paper tries to analyze how and to what extent English language has affected native Indian languages and whether it is a colonial hangover or a will of the Indian people that such a suppression continues in the present day.

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A total of 100 students of University of Delhi were randomly surveyed at the *Vishwavidyalaya* Metro station located in North Delhi, India. This station is located at the entry point of North Campus, University of Delhi and was chosen to ensure random and unbiased survey sample. The University of Delhi and its constituent colleges are a preferred destination for higher education and it attracts students from across India and abroad. The survey focused on understanding the language preference of students for day-to-day communication. The survey also attempted to gather the opinion of the students on the need and implications of having a national language.

The survey shows that out of the 100 students randomly surveyed near the University of Delhi in the National Capital, 75% students considered Hindi to be their mother tongue. The remaining 25% students identify a total of 17 different languages/ dialects, among them, as their mother tongue (Fig 1.).

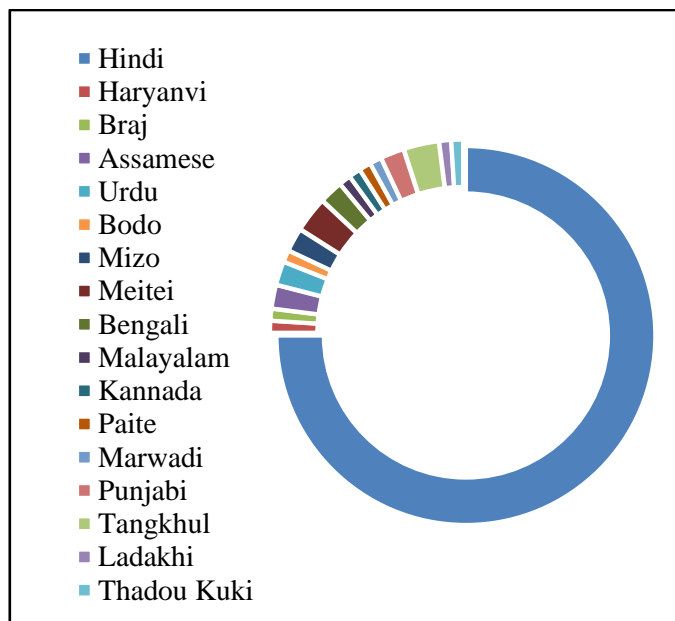


Figure 1. Linguistic diversity of the surveyed population in terms of their mother tongue identified by them.

However, 61% of the respondents carry out verbal communication with their friends mostly in Hindi while 34% of the respondents carry out verbal communication with their friends in English (Fig. 2). 5% of the respondents choose to carry out verbal communication with their friends mainly in their mother tongue (Fig 2). Interestingly, for written communication, 91% of the respondents prefer English as the primary language and only 9% choose to carry out written communication in Hindi (Fig. 3). 60% of the respondents feel the need for selecting one language as a National language for easier

communication across India. Out of these 60%, who feel the need for having a national language, 80% of the respondents felt Hindi to be the most preferred candidate as a National Language. 15% felt that English could be made the National Language while the rest either preferred Sanskrit or were not sure.

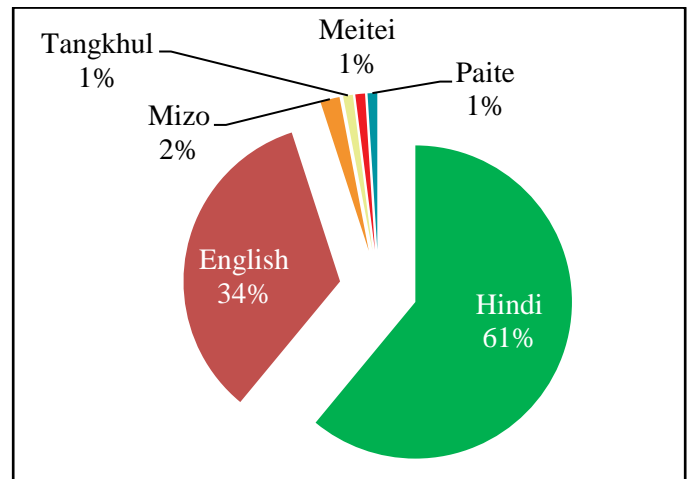


Figure 2. Percentage use of language for verbal communication in the surveyed population.

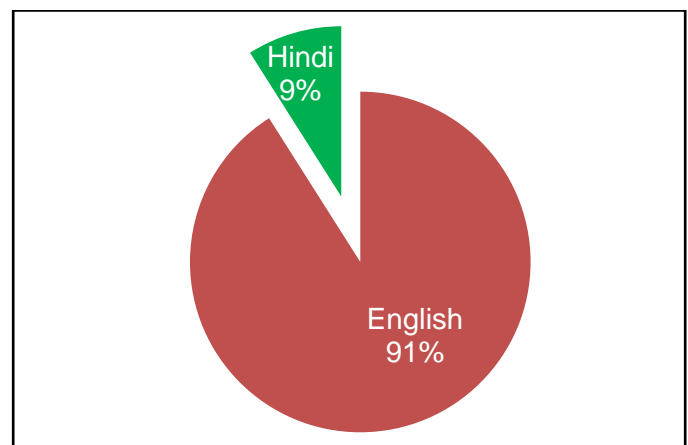


Figure 3. Percentage use of language for written communication in the surveyed population.

The basic knowledge of the mother tongue of each student was checked by asking them to narrate the alphabets of their mother tongue in the order that they appear. Only 29% respondents could narrate the alphabets of their mother tongue in the correct order or attempted to do so. On the other hand, 99% of the total students surveyed could recite the English alphabets in the correct order.

The large number of languages/ dialects that emerged in the survey speak for the linguistic diversity of India. It is interesting to note the disappearance of the use of regional

languages when it comes to written communication. Respondents, whose mother tongue is Hindi and also the non-Hindi speaking respondents use Hindi as their preferred language for verbal communication. This is because they think Hindi is well understood by everyone especially in the National Capital.

A significant finding of this study is the respondents' lack of basic understanding of their mother tongue, even when almost all the respondents could recite the English alphabets fluently. This raises a question on the basic/ primary education system to which these students were exposed to. Clearly, the education system which was provided to these students had a much greater emphasis on English language. All the respondents had undergone basic/ primary education in one or other part of India.

The perception of students towards English is such that its usage is seen as a matter of pride and lack of English fluency leads to the feeling of an inferiority complex. The fact that respondents could not recite the alphabets in their mother tongue did not either come as a surprise to the participating students nor did they feel the need for knowing this.

The survey reveals that in the student community in Delhi, English supersedes every other native language of India and is being extensively used for written communication. While there is a real consensus of whether we should or should not have a common National

Language, there is need for promoting and popularizing all the native Indian languages. These languages need to be given the same amount of attention in our school education, as is being given to English at present. The connection among mother tongue, identity and heritage needs to be carefully carved out and disseminated among the youth today. There has to be greater emphasis to teach and learn local languages in a local manner for sustainable national growth.

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Teaching Environmental Education: Trends and Practices in India. Chong Shimray. New Delhi: Sage Publications, 2016, p. 268

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Teaching Environmental Education: Trends and Practices in India is authored by Dr. Chong Shimray, Assistant Professor in the Department of Education in Science and Mathematics, NCERT. Shimray's book is an exploration of the scenario and development of environmental education in different settings in the Indian context. The book also incorporates global trends and their respective implementation in India.

It is insightful and striking in the sense that it does not only target the factual or potential spheres of environmental education, but also challenges our mindsets by adding the ideological angle. Environmental education has long been viewed through the narrow understanding of the subject being merely limited to tackling pollution.

To break this misconception, the limitations of other disciplinary subjects to address environmental concerns and hence the need for focusing on the interdisciplinary nature of environmental education is discussed in detail. Catering to the readers, the complexity of addressing these concerns and defining the approaches for their solution has been streamlined and made more comprehensible.

The book is systematic in bringing together a fair amount of information and methods and practices and dividing them under meaningful sections. There is special attention given to the inclusion of environmental education in the school curriculum and the strategies for the same have been traced alongside the evolution of the subject till date in India. Thus, as an educational tool at the formal schooling level, the book delivers excellently.

Further, the book serves as a considerable aid especially to those interested in the field of teaching the subject. It analyses the existing teacher-education courses vis-a-vis environmental education and explains the barriers that hinder the popularization of the subject in teacher-education courses. With this, the book also succeeds to an extent to equip the reader with clarity regarding the similarities or differences between environmental education and full-fledged education for sustainable development and its importance in today's context.

Additionally, the book sports supporting illustrations, pictures and tables along with highlighted opinions and findings of various professionals and researchers for the ease of understanding.

However, the book falls short in some areas as it seems to view 'education' itself through a peephole and restricts its scope to only formal school education. For overall growth of the subject, informal and non-formal environment education needs to be stressed upon too.

Moreover, as the book is mainly a guide for teachers and educators to deliver courses, a more creative approach rather than the conventional explanatory approach would have encouraged them to deliver courses in the same way. Thus the scope of the book to uplift the value of the subject as something more than just to memorise and pen down in exam papers is not fully utilised.

To sum up, the book proves to be effective in its attempt to consolidate appropriate material for the study of environmental education. It makes a strong case for the necessity of the subject to be studied separately and given more attention. As a preliminary resource material for students and teachers across India, it can definitely be termed a success.

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Importance of Field Studies in Environmental Education: An Experience from Keoladeo National Park, Rajasthan

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Environmental education at undergraduate level is comprehensive and inter-disciplinary which draws its input and content from a variety of subjects. A large part of conceptual framework generated through classroom teaching has an important application to real life problems and scenarios. This necessitates the in-situ (on-site) training of students regarding several components and processes of environment. To develop the correct attitude towards classroom education and make connections between study and application, field work is very important for students. Field based enquiry brings students into direct contact with the nature. Students are allowed to apply their own knowledge, skills and classroom teaching to make observations, order their experiences and set their own priorities towards becoming autonomous, self-directed learners.

Field activities require application of information and skills from investigative approaches to explain natural phenomenon and occurrences, which broadens the investigators awareness and emphasize connections between ideas and practical realities. Being a group learning experience, field work also enhances the ability of students to work together to create a common meaningful understanding of the subject at hand.

A field visit undertaken by students to Keoladeo National Park, Bharatpur (Rajasthan) was particularly useful in providing necessary and delightful insight to the students regarding biodiversity, especially avian diversity, the importance of variety of habitats including wetland and various associated ecological processes. Keoladeo National Park, Bharatpur (27° 10.085'N; 77° 31.470'E) is a large marsh (~30 sq. km) situated at the confluence of

Banganga and Gambhir River. The park, which once served as a private hunting ground for the local ruler, was declared as a reserved forest area in 1967 and later upgraded to a National Park in 1981. With its formal inclusion in the protected area network, cattle grazing was completely banned inside the park in 1982, which later turned out to be an ecological disaster as the park's habitat started to deteriorate and the bird diversity was also on decline (Vijyan, 1987). In absence of the regulatory pressure of herbivory, the wetlands of Bharatpur were on a slow move towards climax communities and several weeds and tall grasses were filling the wetlands, ultimately reducing the bird habitat and food. Fortunately, with several studies pointing out this problem and with active efforts of Bombay Natural History Society (BNHS), cattle ban was lifted from the park in 1991. Since then the park has been an active breeding site for several heronry birds and also a wintering ground for large number of migratory waterfowls. This park once used to be the only known wintering site for the central population of critically endangered Siberian Crane (*Leucogeranus leucogeranus*), but the last pair was reported way back in 2002.

Keoladeo National Park is divided into a number of blocks by embankments which receives water through an intricate network of canals and a few solar powered ground-water pumps. In the marshes between these embankments, clumps of *Acacia* sp. trees growing on mounds are used by Painted Storks and other colonial waterbirds for nesting (Tiwary and Urfi, 2016). These heronries are known to have existed at this site for more than 100 years (Ali, 1953; Ali and Vijayan, 1983; Sankhala 1990). Some of the nesting species observed during our visit were Painted Stork (*Mycteria leucocephala*), Little Cormorant (*Phalacrocorax niger*), Indian Cormorant (*Phalacrocorax fuscicollis*), Great

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Cormorant (*Phalacrocorax carbo*), Intermediate Egret (*Egretta intermedia*), LE: Little Egret (*Egretta garzetta*), Indian Pond Heron (*Ardeola grayii*) and Black-headed Ibis (*Threskiornis melanocephalus*). Along with several species of resident herons, storks, darters, cormorants and egrets this park also receives large number of migratory ducks and geese. Some of the waterfowls sighted during our visit were Greylag Goose (*Anser anser*), Bar-headed Goose (*Anser indicus*), Ruddy Shelduck (*Tadorna ferruginea*), Gadwall (*Anas strepera*), Eurasian Wigeon (*Anas Penelope*), Spot-billed Duck (*Anas poecilorhyncha*), Northern Pintail (*Anas acuta*), Garganey (*Anas querquedula*) and Common Teal (*Anas crecca*).

Apart from having a rich wetland habitat, the park also has a unique mosaic of habitats including forests, grasslands and scrub woodlands. The forested area which is dominated by Kadam (*Mitragyna parvifolia*), Babul (*Acacia nilotica*) and Jamun (*Syzygium cumini*) supports a rich diversity of arboreal and woodland avifauna. During our visit we observed several woodland species like Grey Francolin (*Francolinus pondicerianus*), Indian Peafowl (*Pavo cristatus*), Eurasian Collared Dove (*Streptopelia decaocto*), Yellow-legged green Pigeon (*Treron phoenicopterus*), Laughing Dove (*Streptopelia senegalensis*), Rose-ringed Parakeet (*Psittacula krameri*), Greater coucal (*Centropus sinensis*), Ashy Prinia (*Prinia socialis*), Red whiskered Bulbul (*Pycnonotus jocosus*), Red-vented Bulbul (*Pycnonotus cafer*), Oriental Magpie-robin (*Copsychus saularis*), Indian Robin (*Saxicoloides fulicatus*) and Purple Sunbird (*Cinnyris asiaticus*). We also sighted open area species like Red-wattled Lapwing (*Vanellus indicus*), Green Bee-eater (*Merops orientalis*) and Black Drongo (*Dicrurus macrocercus*).

The Keoladeo National Park is also included in the 'Important Bird Area' network for supporting more than

20,000 individuals of around 350 species of birds (Islam and Rahmani, 2004). Some of the common herbivores sighted from the park were Sambar (*Cervus unicolor*) and Bluebull (*Boselaphus tragocamelus*). Owing to the presence of variety of habitats and enormous avifaunal diversity, Keoladeo receives large number of visitors every year which leads to a significant revenue generation from entry tickets and transportation within the park. During the financial year 2014-15, 1.35 Lakh tourists visited the park generating an approx. earning of 1.13 Crore. With an effective scientific management strategy, active involvement of researchers and people's interest, this park can continue to be, what Kailash Sankhala (1990) envisioned, as the 'Gardens of God'.

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