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A COMPREHENSIVE REVIEW ON NOVEL TECHNOLOGICAL OPPORTUNITIES FOR ACHIEVING SUSTAINABLE ECOSYSTEM

Ms. Rashmi Dongre, Assistant Professor, Tilak Maharashtra Vidyapeeth, Pune, rashmibichkar15@gmail.com
Ms. Supriya Nagarkar, Assistant Professor, Tilak Maharashtra Vidyapeeth, Pune, supriyanagarkar@gmail.com
Dr. Vikas Prasad, Research Guide, Tilak Maharashtra Vidyapeeth, Pune, drvikaspd@gmail.com

Abstract
The term 'technology' refers to the actual application of scientific knowledge, as well as the apparatus and instruments that follow. We are currently living in a period of fast transition, in which technological advancements are transforming the way we live while also propelling us farther into the abyss of disaster, as seen by climate change and resource scarcity.
Over the last several decades, the Information Technology sector, as well as customers of the industry's products and services, have profited from fast growing computing performance for all types of devices. Digitalization is projected to have far-reaching ('transformative') implications for the economy, society, and politics, as well as for the planet as a whole. This encompasses hardware (ICT equipment, data centers, data transmission networks) as well as software, digital technologies, and applications — ranging from robotics to the Internet of Things (IoT), to distributed ledger technologies like blockchain, to Artificial Intelligence (AI). Questions regarding the role of technology become even more relevant in the context of the effort to catalyze a Great Transition to a sustainable global society, in which fundamental changes in culture, values, consumer patterns, governance, business, and institutions are expected. This research paper contributes to the dissemination of recent emerging technological trends that may contribute to ecosystem and biodiversity sustainability.
Keywords: *Sustainability, ecosystem, biodiversity, energy resources, conservation of resources, IOT, Artificial Intelligence, Sensor Networks etc*

I Introduction
Technology is radically altering how we live, work, and interact with one another and the rest of the world. Current advances are unprecedented in terms of speed, breadth, and depth, and they are disrupting practically every sector in every country. The introduction of new technologies has the potential to alter environmental protection now more than ever.
The search for better, more intelligent ways to aid our development has always been a driving force behind technical advancement [3]. As our civilization faces a new and unprecedented problem, technology can help to decouple development, environmental deterioration, and ecosystem equilibrium. No human technology will ever be able to totally replace 'nature's technology,' which has been refined over hundreds of millions of years in supplying critical functions to keep life on Earth afloat.
A fruitful, diverse natural world and a stable climate have been and will continue to be the foundations of our civilization's success [5]. A major challenge in earlier technological revolutions has been our casual attitude toward healthy natural systems such as forests, oceans, and river basins (all of which are anchored and sustained by biodiversity), rather than recognizing them as a vital condition for growth.
In just over 40 years, the world's wildlife has declined by 60% on land, sea, and freshwater, with a staggering two-thirds decrease expected by 2020 if current patterns continue. In less than a generation, this has occurred. In comparison to the hundreds of millions of years some of these species have spent on our planet, a blink of an eye.
Unabated deforestation is putting pressure on forests like never before, while 90 percent of the world's seafood stocks are overfished at sea [7].

This research paper aims in highlighting the novel technological opportunities that are emerging, which can contribute in achieving sustainability of ecosystem and protection of environment.

We are currently exploiting resources and ecosystem services as if we had 1.7 Earths, yet such an ecological overshoot is only viable for a certain amount of time before ecosystems degrade and eventually collapse.

The health and function of critical ecosystems such as forests, the ocean, rivers, and wetlands will be impacted if global biodiversity continues to diminish. When you add in the effects of climate change, as evidenced by scientists' warnings and the rising frequency and intensity of extreme weather events around the world, it's going to be terrible for the planet's ecological balance and our survival.

II Need for Study

Sustainability enhances our quality of life while also safeguarding our ecosystem and natural resources for future generations. In the business world, sustainability is linked to a company's holistic approach, which considers everything from manufacturing to logistics to customer service.

It's time to concentrate on the solutions that we now know about or that have the potential to be developed, and this is where technology, combined with behavioral change, may assist us in reviving the health of our environment and planet. Technology can revolutionize how we identify, measure, track, and value the numerous services and resources that nature supplies us with, from the high seas to the deepest depths of the world's most thick forests.

This paper contributes to filling these gaps, and at the same time, extends the construct of the technologies for sustainable ecosystem. The following research question guided the study:

What are the various novel technological opportunities available to achieve sustainability of ecosystem?

III Review of Literature

The structure of the world's ecosystems changed faster in the second half of the twentieth century than at any other time in recorded human history, and nearly all of the planet's ecosystems have now been extensively altered by human actions. The conversion of almost a quarter (24%) of the Earth's terrestrial surface to agricultural systems has been the most important alteration in ecosystem structure [1].

Reservoir storage capacity quadrupled between 1960 and 2000, resulting in three to six times the volume of water contained behind major dams compared to natural river routes (this excludes natural lakes) (Figure 1)

Ecosystems altered faster in the second half of the twentieth century than at any other period in recorded human history. The conversion of forests and grasslands to crops, the diversion and storage of freshwater behind dams, and the loss of mangrove and coral reef habitats are only a few of the most significant changes.

Marine and freshwater ecosystems, temperate broadleaf forests, temperate grasslands, Mediterranean forests, and tropical dry forests are among the ecosystems and biomes that have been most significantly influenced by human activities on a worldwide scale. (Figure 2).

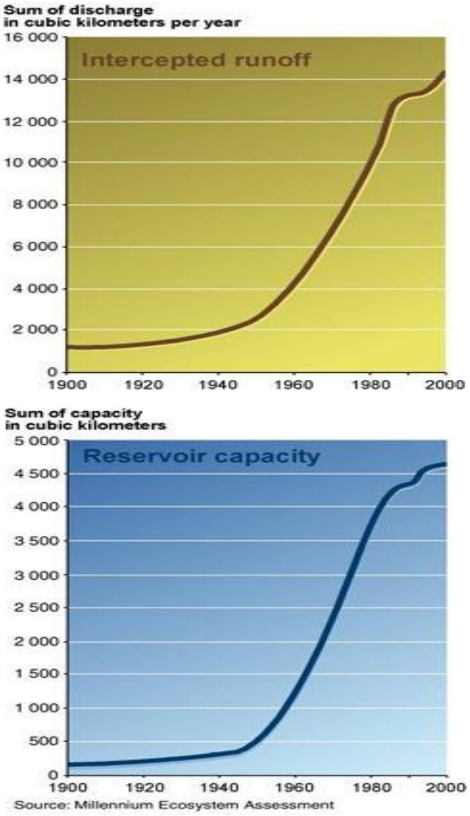

Figure 1 Reservoir Storage capacity

Within marine systems, the world's demand for food and animal feed has resulted in such intense fishing pressure over the last 50 years that the biomass of both targeted species and those caught accidentally (the "bycatch") has been reduced to one tenth of what it was prior to the onset of industrial fishing in much of the world. Globally, the degradation of fisheries is evident in the fact that, when populations of higher tropic level species are depleted, more fish are being caught from the less desirable lower tropic levels [6]. (Figure 3).

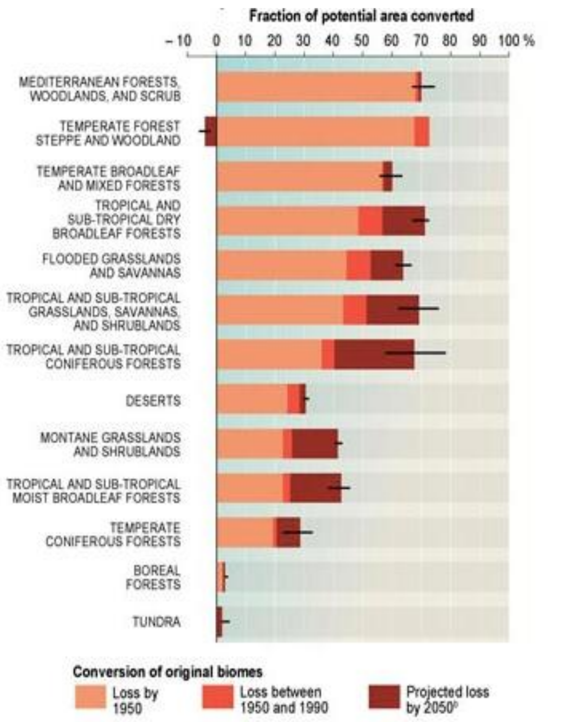

Figure 2 Conversions of Ecosystems

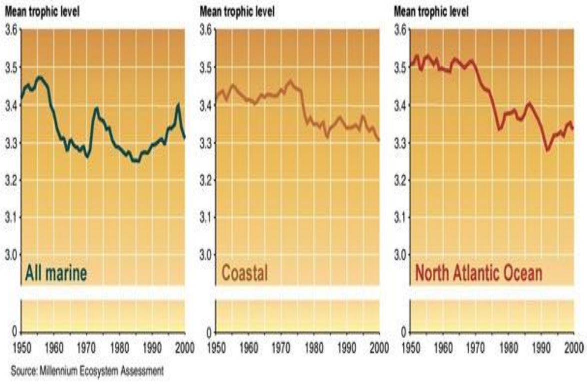

Figure 3 Decline in Tropic Level of Fisheries Catch Since 1950

III Research Findings

Technology allows us to work smarter by improving our ability to evaluate data, enhance workflow, streamline supply chains, discover problems faster, and optimize manufacturing processes, among other things [9]. Less waste in the system translates to more environmentally friendly behaviors all around. Instead, new technologies have resulted in more sustainable practices, improved natural resource stewardship, and the switch to solar and renewable energy sources. And it's been proven that they have a huge good impact on the environment.

Some examples of technology-efficient energy solutions are listed below:

- Use of fuel cells
- Use of lithium-air batteries,
- Use of hydrogen energy storage and thermal energy collectors.
- Use of Smart grids assist in moving the generated electricity

Also following are the novel technological opportunities available that could contribute in achieving a sustainable ecosystem by conserving the environment:

a) Remote sensing in planning and monitoring

Environmental monitoring through remote sensing is based on extracting information about targets on the earth's surface, or processes of interest over time, from data and images received by sensors on satellites and other platforms as shown in Figure 4

Remote sensing is crucial for planning, monitoring, and assessing the impact on the ground. It has allowed WWF to keep track of extractive industry developments in socially and environmentally vulnerable areas.

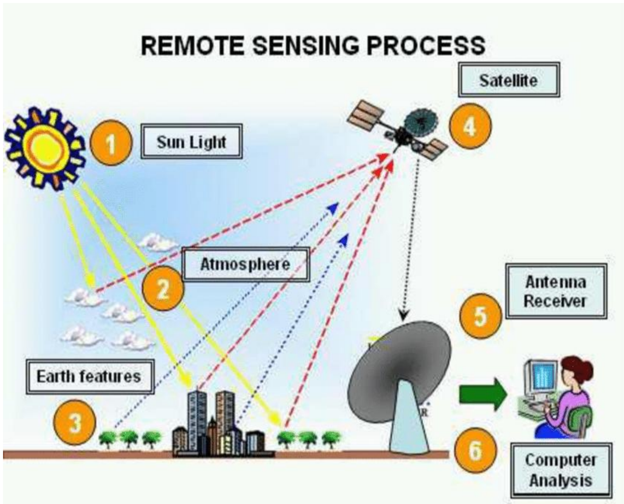

Figure 4 Remote sensing process

Remote sensing applications in hydrological modeling, watershed mapping, energy and water flux estimation, fractional vegetation cover, impervious surface area mapping, urban modeling, and drought predictions based on remotely sensed data are discussed.

b) Thermal imaging to combat poaching

Rangers can use thermal imaging video cameras to catch poachers at an unprecedented rate and dissuade many more from even trying. In addition to direct actions to prevent poaching, WWF use technology to track down wildlife smugglers. Figure 5 depicts a typical thermal imaging system work method for monitoring poaching, in which the instrument contains a sensor and a display unit that captures the target of a distant object. Thermographic scanners have software backup capabilities for transferring, processing, and analyzing acquired images, but they are unable to detect item temperature if the medium is separated or covered by glass, polythene, or other materials.

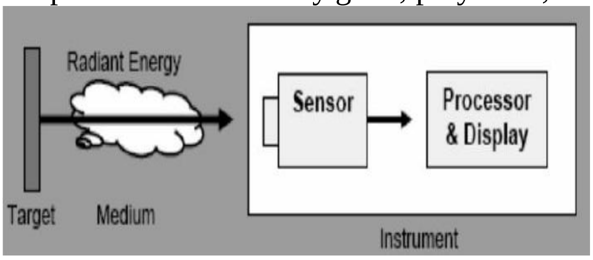

Figure 5 Thermal Imaging system

c) Artificial Intelligence to track wildlife

Artificial Intelligence (AI), which seems so far removed from the natural world, is assisting conservation efforts. Wild Me uses artificial intelligence (AI) and cutting-edge cloud computing to discover animal species on the verge of extinction. Wildbook, a platform that analyses hundreds of photographs to identify species and individual animals, is powered by computer vision and deep learning algorithms developed by Wild Me.

DeepMind, a startup based in the United Kingdom, has created an AI-based model for identifying animal species and counting their numbers. It has been implemented in Tanzania's Serengeti National Park. Scientists use AI to distinguish wild creatures and try to save endangered species before it's too late. In China, WWF and tech giant Intel are using artificial intelligence to help safeguard wild tigers and their habitats, as well as countless other species, carbon storage, critical watersheds, and local populations.

d) IoT for Environment Protection

Governments may employ IoT in almost any scenario for public services in order to make cities more environmentally friendly.

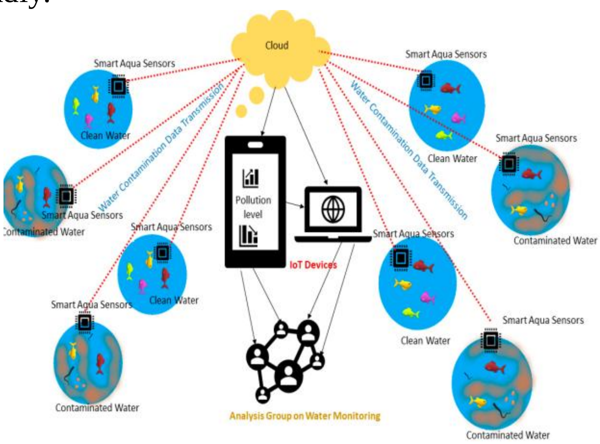

Figure 6 IoT based smart environment system

Figure 6 depicts a smart environment system based on the Internet of Things. The example in this diagram demonstrates the monitoring and control of water contamination utilising a cloud-based system that connects IoT devices and various appropriate sensors [10].

Because all IoT devices have AI and machine learning capabilities, the system can monitor whether the water is contaminated or clean using IoT devices. The organisation, which monitors the water quality of various water sources, has access to the cloud via data acquired from various sensors, such as an aqua sensor, and is exposed to IoT-based analysis where the quality check is performed.

Sensor-enabled devices can collect data on sewage, air quality, and rubbish to assist communities monitors their environmental impact. Woods, rivers, lakes, and oceans can all benefit from such devices.

e) GPS Technology

The use of GPS technology aids in the understanding and forecasting of environmental changes. The water content of the atmosphere can be calculated by incorporating GPS readings with operational methods used by meteorologists, boosting the accuracy of weather forecasts.

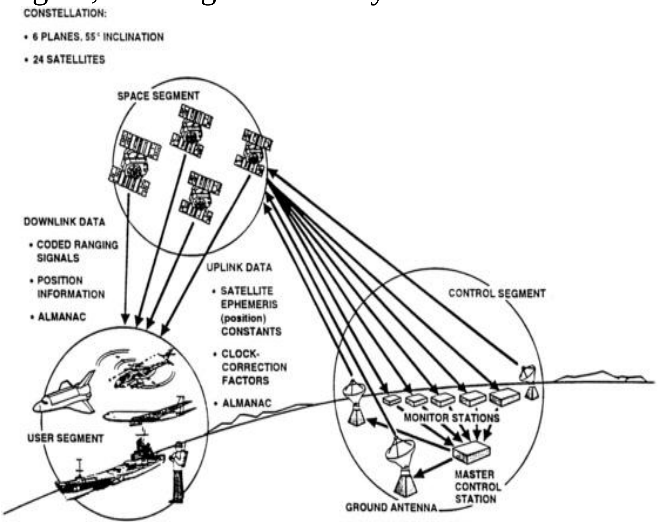

Figure 7 GPS Technology for Geosciences

The space segment, the operational control segment (OCS), and the user equipment segment are the three separate segments that make up the GPS's technical and operational properties. The segments are linked together via GPS signals, which are broadcast by each satellite and carry data to both user equipment and ground control centers. The signals and portions of the GPS are briefly described in Figure 7.

GPS has resulted in significant environmental benefits, including reduced carbon emissions, increased water efficiency, reduced usage of environmentally sensitive inputs, and reduced waste. Many aspects of the forest business have benefited from the use of GPS. Fire prevention and control, harvesting operations, insect infestation, border determination, and aerial spraying are all common uses.

f) Sensor Network Technology

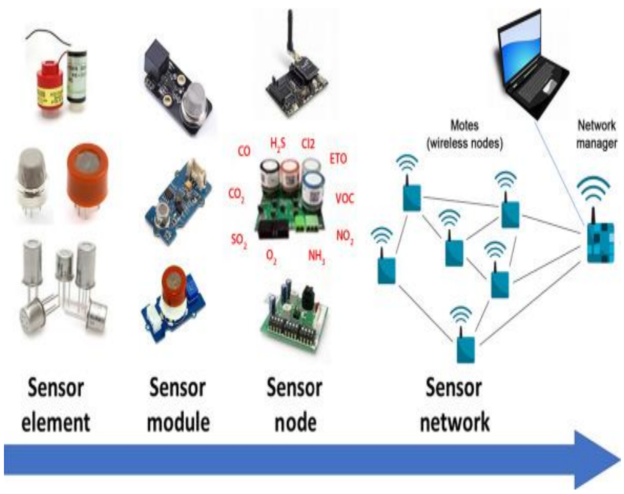

Figure 8 LCSNs Network

In the environmental sciences, the usage of low-cost sensor networks (LCSNs) is growing in popularity, and the unparalleled monitoring data provided enables study across a wide range of fields and applications [3].

Wireless sensor networks use low-cost sensors incorporated in low-power sensor systems to monitor harmful chemicals and particle matter at the outdoor level with high spatial and temporal precision (Figure 8).

In terms of smart and sustainable cities and Internet-of-Things (IoT) applications, examples of fixed sensor networks and mobile sensing on ground vehicles and unmanned aerial vehicles (UAV) are shown as a supplement to expensive air quality monitoring stations. The performance of air quality sensors in existing worldwide wireless sensor networks is described, with a focus on data quality objectives.

Existing LCSNs are primarily concerned with detecting and mitigating phenomena that directly affect humans, such as flooding, air pollution, and geo-hazards.

IV Conclusions

The rate of technological advancement is quickening. It will probably certainly do so in the future as well. We are certain that, in terms of the quality of the data they report, conservation technologies will continue to improve, becoming cheaper, smaller, less invasive, and more common.

Without jeopardizing the Earth's ecosystem or future generations' chances, technology will support and promote a good living for all of its residents, in both affluent and currently impoverished countries. Basic human necessities must be provided, and desires for freedom, belonging, and self-realization must be realized to the greatest extent feasible. It does not always imply that material output and consumption should be maximized.

As a result, we study technological innovation in the context of the good life, and how it might be supported or threatened depending on how human actions and institutions impact and guide technological advancement.

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