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Large and small-scale applications of AI and ML to prevent and detect climate change: A Review

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Abstract: Research conducted on environmental factors and the causes of changing climate has been increasing since the last few decades as a rapid decrease in the quality of air, oceans, and water has been noticed. Artificial Intelligence and Machine Learning being existing for so many years have made their way through many theoretical and practical applications in almost every field of research. But combining such technologies to tackle the factors leading to climate change has proven to be ground-breaking. Owing to this more and more researches are being conducted using this fusion and many real-time models are also used today to provide environmental data so that both the major environmental-based companies and a common human being can act upon their parts of contributing to the environment. The present review elaborates in detail the many applications of AI and ML being used by some of the major multi-national corporations as well as the researchers to present their ideas and experiments using these advanced tools to offer efficiency in practices used by people in our community. These practices span from agricultural irrigation methods to detecting the pollution in the air and its source. The review also details the truth behind the real-time application of AI being used by Microsoft, Google, and IBM, and other big companies to help in preventing climate change.

Keywords: Climate Change, Machine Learning, Artificial Intelligence, Microsoft Azure, DeepMinds, Green Horizons.

I. INTRODUCTION

A. *Definitions*

It is since the 1950s the concepts of Artificial Intelligence have been around as being used by researchers, even today, the capabilities AI holds is improving rapidly because of the factors like faster, powerful, and highly developed computers, the abundantly increasing cheap storage; the ability to collect a vast amount of data using sensors, internet, and satellites; and the open availability of data and open-source software. Artificial Intelligence can rapidly perceive patterns which humans can't, can more efficiently make better predictions, and give better recommendations. The one-line definition of Artificial Intelligence is the ability of computers to abstract, reason, communicate, and understand like a human brain. However, that sort of technology has not been developed till today, as it would involve 83,000 processors to work in 40 minutes, for computing 1% of what the human brain can calculate in 1 second. The current used AI tools are narrow, task-oriented and in some way can perform some tasks better than humans like forecasting weather and recognize different speech signals. Recommending picture tags on Facebook and classifying among images in the example of narrow Artificial Intelligence tools. When Amazon and Netflix recommend products and shows depending solely on the history of purchase and viewing, the platforms are making use of Machine Learning. Machine Learning makes use of different algorithms for solving a problem, by learning from the data given to the system. The more data is given to a system for analysis, the more accurate a system solves the problems for achieving its goals. A subset of Machine Learning is Deep Learning, which involves, processing in a neural network framework connected to the human brain neurons. Every layer with a separate task assigned, with information passing through these neurons to give weights depending on the level of accuracy for the task assigned. The results are then estimated by the wights in total.

B. *AI as a game-changer*

Many big companies like Google, and Microsoft believed that AI compensating the tools of Deep Learning and Machine Learning is perceived as the Game Change specifically for the issues related to climate change or the rapidly changing environment. Many companies are working to bring AI tools into practical usage for controlling climatic issues.

- AI for Earth by Microsoft invented in 2017, is an Azure Machine Learning technology formed by Microsoft used to compute the sustainability programs for the environment. It was first initiated to access more powerful and practical Machine Learning and AI technology by the researchers, to help them in tackling the issue of climate change. AI for Earth ever since has awarded more than 230 grants in almost 64 countries around the world covering the research areas like biodiversity, climate change, agriculture, water. etc.
- In Washington, USA, a program named "Long Live the King" was initiated for restoring the declining salmon and steelhead populations. In 2018, the program was funded by Microsoft's AI for Earth which was used by the researchers to enhance their model, gathering growth data of the fishes, tracking the moments of marine mammals,

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and monitoring the conditions. It was proven that this AI model helped in improving harvest, hatchery, protection, and supporting the habitat, managing the ecosystem, and provided better efforts to restore.

- Maria Uriarte, a famous Ecology, Evolution, and Environmental Biology professor from Columbia University, and Tian Zheng a Data Science Institute Professor, were granted Microsoft funding to study the effects of Hurricanes on the Forests of Puerto Rico. They researched on gathering information on how the tropical storms are worsening the climate changes, and how it affects the distribution of different species of trees in the forest. The researchers stated that their research work would not be possible without using Artificial Intelligence. The researchers and their team used AI tools for analysing the high-resolution photographs (flyover images) and match the data collected and mapper by Uriarte, identifying every tree in the plots given. This data was used for extrapolating on a larger region. The plat data can be used for a training algorithm called Learning in AI language, and for validating the working of the algorithm.
- PAWS (Protection Assistant for Wildlife Security), a project from Southern California University, is another prediction model based on Machine Learning to detect that poaching might occur in the coming years. This algorithm was used to analyse poachers' behavior and ranger patrols using the criminal data. This project was also given a Microsoft granted expanding the project for incorporating real-time data for enabling the rangers for enhancing their patrols.
- AI tools are also being implemented to manage the intermittence of renewable energy, to handle power fluctuations in a better way, more features being incorporated into a grid, as well as to improve the storage of energy. SLAC National Accelerator Laboratory, Energy Department under the Stanford University applied AI and ML for identifying grid vulnerabilities, strengthening them for any future failures, and restoring power more efficiently. This system was first used in the regions of California, analysing renewable battery storage, power sources data, and satellite images which can show the over-power of trees lines, which can cause issues in case of disasters like a storm. The objective of such models is the automatic and uninterrupted management of renewable energy and its recovery from failure without any human intervention.
- AI is also being used by many Wind Companies, to get every propeller of the Wind turbines to produce more electricity on every rotation using operational and real-time data. On large-scale wind farms, the propellers in the front row create a wake and decrease the efficiency of propellers behind the first row. The Artificial Intelligence tools would enable every propeller for determining the direction and speed of wind reflected from other propellers and accordingly adjust with it. National Oceanic and Atmospheric Administration, Energy Department, conducted a model using the AI tools for a better understanding of atmospheric conditions for projecting the energy output more accurately on the wind farms.
- The Green Horizon project conducted in IBM, China makes use of an AI system that could track pollution sources, forecast air pollution, and come up with new strategies for dealing with the issues of air pollution. Such models can help in determining if it would be effective, restricting the operations of some power plants, or lessen the number of cars driven per day for reducing the pollution level in some specific areas. There also have been other IBM models using AI to help planning the cities to effectively tackle future heat waves. AI on an urban scale and simulate climate and can come up with various methods for testing how it can ease the heat waves. A practical example of such a model is that if the city is planning on planting more trees, the AI and ML models can be used for determining the best places for planting them to provide an optimum tree coverage and reducing heat from the pavements.

C. *Why is AI being used*

It's not just the past few years that the climate has started to change at such a rapid pace. This gradual change has been ongoing since the late 90s and can be said that today the conditions are more drastic than ever, that to act upon these changes is the primary concern for a better future. When the technology was first mixed with theoretical research on climate change, the results were more promising. Hence the technology of AI was merged with the research conducted on climate change, it is because AI proved to be a system that can sense our environment, can learn, think, and respond in a way required. This simple definition was reported in World Economic Forum after research conducted using AI for the earth. This review is conducted in parts, respective to the application of AI in different environmental fields.

II. REAL-TIME APPLICATIONS OF AI

Accurate projections not only in environmental studies but in every scientific field are important. Different climatic models result in different valued predictions, mostly because the data used by these models are broken down into discrete parts, on temporal and spatial scales. IPCC: "Intergovernmental Panel on Climate Change" releases their reports from the data resulting from many such climate models by averaging the output values from these models. This simply means that all the used models are given the same and equal weightage. AI is being used for determining which model produces more reliable results by giving additional weight to the ones with accurate predictions and ruling out the ones with the least matched results.

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An IBM research initiative by the name Green Horizons was applied on global terms when it was used in cities like Beijing, Johannesburg, New Delhi, and Other highly polluted regions. Green Horizons made use of two technologies, IoT (Internet of Things) and cognitive computing. IoT used for predicting the rate of pollution and cognitive computing with a superior ability of data processing were merged with Machine Learning for ingesting source data from traffic cameras and meteorological satellites to adjust its predictive models. As a result, it helped in forecasting pollution level 72 hours in advance along with the source of pollution and where it would go. This initiative was used by the utility companies, factories, and the government for better understanding the cause of decreasing air quality and tackling the issue of pollution and climate change. Green Horizons, in collaboration with EPB (Environmental Protection Bureau) of Beijing, came up with the most advanced Air quality forecast and decision support system used for generating predictions of pollution 10-days advance, with a kilometer-by-kilometer range of the pollution and where it is likely headed. Three years Since December 2015 when it was first initiated, the government of Beijing was able to achieve a 20-25% reduction in air pollutants. [1]

Google came up with an Artificial Intelligence by the name DeepMinds, [2] which they used to save the amount of energy utilized in their own data centers. A 40% decrease in the cooling energy utilization was noticed in Google Search, YouTube, Gmail, and other Google services and their data centers. The same algorithms and methodologies used in DeepMind can also be used in other larger-sized manufacturing plans to reduce the energy wastage in their energy grids. For Google, the primary energy usage source is cooling the data centers, this type of large-scale cooling is accomplished typically using industrial chillers, towers, and pumps. DeepMind is a neural network trained system operating on different scenarios and parameters of the working of data centers, hence understanding the dynamics more clearly and optimize the efficiency levels. The training of neural network used in DeepMind was done by inputting already recorded data from thousands of numbers of sensors like temperature levels, power values, speed of pumps, setpoints, etc. The training is done on future PUE on average (Power Usage Effectiveness) defining the ratio of the total energy used to the IT energy usage. Additional frameworks of Deep neural networks were also applied for predicting future pressure and temperature of the data centers, one hour in advance. The only objective of DeepMind was simulating the recommendations for the PUE model to make sure the operating constraints are neither limited nor exceeded. The following graph released by the company was used to show a 40% reduction in energy usage which is equal to a 15% reduction in overall overhead of PUE, after non-cooling and other electrical losses inefficiencies. It also helped in producing the lowest PUE Google has ever seen. [3]

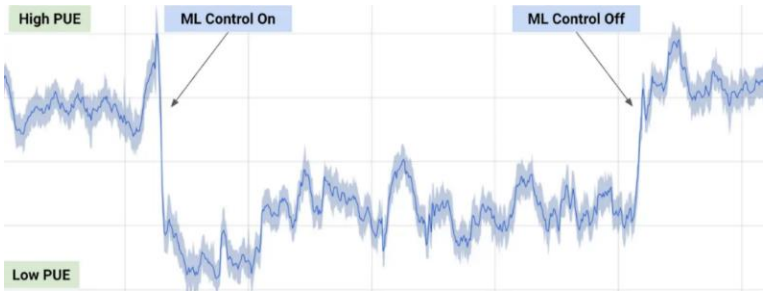

Fig. 1 Reduction bill graph using DeepMind Technology

TABLE I APPLICATION OF DEEPMIND IN REAL-TIME SCENARIOS

Year	Releases
July’ 2016	AI-induced DeepMind announced a 15% lesser consumption of energy in Google's data centers using the ML framework.
March’ 2017	DeepMind algorithm used for anticipating the supply and demand of energy with the potential of cutting down the energy consumption by 10% in the U.K.
February’ 2019	AI DeepMind technology used to boost the efficiency of wind energy, 20% increases the production of energy was reported using the AI framework in one of the largest renewable energy projects in the United States.

Microsoft the biggest company in the world is also working towards the steps of environmental conservation. Microsoft came up with *AI for Earth* in 2017, building two separate Applications Programming Interface (APIs) namely the species classification API and the land coverage mapping API. *AI for Earth* also offers grants in two forms: (a) Data Labelling Services, used in acquiring larger data sets for processing in AI networks, and (b) Microsoft Azure computer credits. *Microsoft Azure* [4] is an important platform for the researchers working on the programs towards environmental

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sustainability. These APIs take environmental research one step further, by offering their services to those who might not be able to access it on their own, by centralizing every kind of data from global agencies in the cloud platform of Microsoft Azure. Using these Apps any person can take and upload pictures which can be used as a database for the researchers to work on different issues related to climate change. Until today a total of 230 grants have been already awarded to several projects going on around the world. Every researcher working under these grants uploads their data into Azure which could be further used by researchers to expand their knowledge, making AI an important tool used to enhance the conditions of the planet. Some of the most famous AI for Earth projects are explained as.

(a) SilviaTerra using the AI for Earth grant for developing professional forestry tools used for conserving the forests more effectively. The base of this project is a satellite image used for predicting the population of several trees. [5]
(b) FarmBeats first started in the year 2015, was established to improve the practices of farming using edge computing, IoT, and AI. The objective of this project was to create an end-to-end platform that replaces the concept of "guesswork" of the farmers with actual data which helps them in making decisions about their land, the crops, irrigation, etc. This is done by using sensors, images, drones, and historic data which is fed into the Azure system to produce results that can be effective for the farmers to produce higher yields. [6]

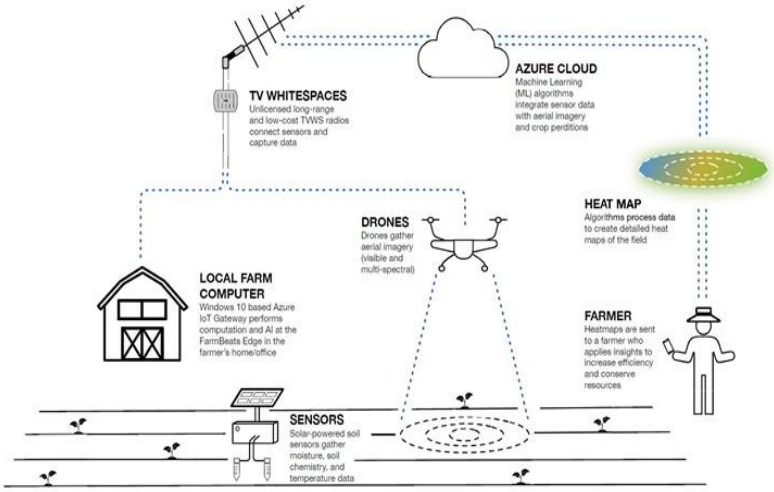

Fig. 2 Microsoft Azure-based FarmBeats system
Source: https://venturebeat.com/

GRAF short for the "Global High-Resolution Atmospheric Forecasting" is the new Artificial Intelligence-driven system used to forecast atmospheric data, running on IMP Power9 purpose-built supercomputers called Dyeus. It helps in mapping billions of numbers of points on the globe hence producing hyperlocal images of weather spanning 12 hours in the future. All these predictions fall into a forecasting engine (multi-mode) which part-company of IBM *The Weather Company*, makes use of for refining for the last 20 years. GRAF makes use of complex algorithms of Machine Learning system, and the results are combined with nearly 100 other systems of weather forecast employed in other parts of the world, including ECMWF, a European Model, and the GRAF American Model. This model carries out a comparison using the factors like precipitation, temperature from every employed model in terms of time, geography, recent accuracy of the forecast, and the type of weather and assigned the correction factors and relative weights to it. A system that blends these contributed weights for estimating the final forecast. This whole functioning involved 400TB of data collecting daily, providing future weather forecast for 2-Billions locations of the world, and is capable of carrying out 25-Billion weather forecast every day. GRAF became the first-ever model operational to forecast weather on global terms which resulted in higher resolution, and more rapidly updating frequency running on supercomputer optimized system for GPUs. [7]

TABLE II APPLICATION OF DEEPMIND IN REAL-TIME SCENARIOS (CONTINUED)

Year	Releases
November' 2019	IBM used POWER9 and Fortran in GRAF, the first hourly, and high-resolution model for a weather forecast.
December' 2019	The Weather Company and New-Zealand-based company Vector Energy use data analytics and AI for predicting and pre-empting downed lines and poles.

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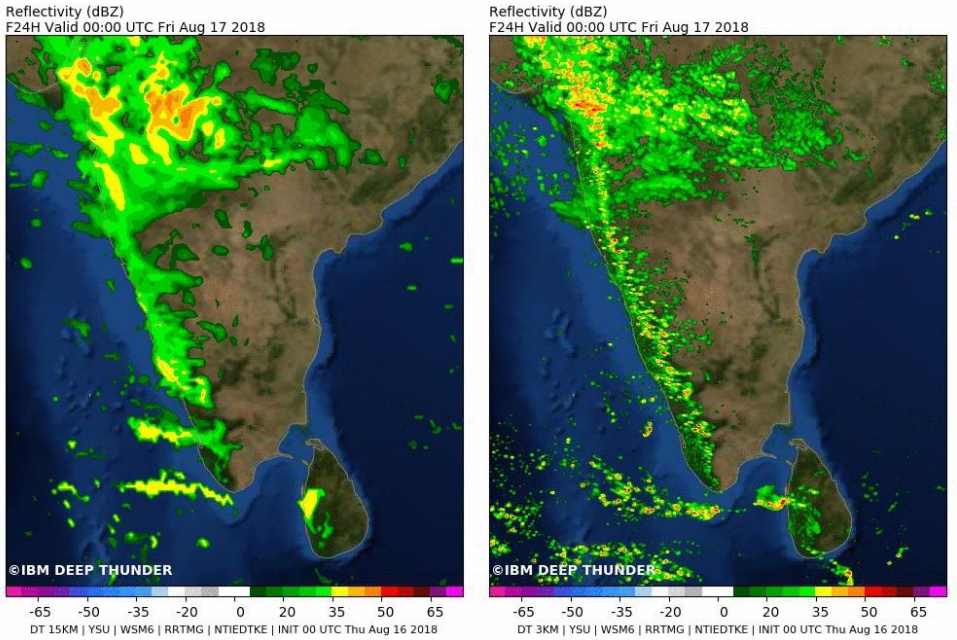

Fig. 3: Global High-Resolution Atmospheric Forecasting

Source: https://www.ibm.com/

Google cloud and *NESDIS* National Oceanic and Atmospheric Administration's (NOAA) Satellite and Information Service made use of the AI and ML tools to enhance the NOAA's environmental and satellite data, this project was first announced in October 2020. Under the OTA (Other Transaction Authority) Google and NESDID released this project with a prime objective of enhancing weather forecasting and environmental monitoring, to produce more results in research related to climate data and hence more technical innovations in the field. This project was objected initially to develop a small-scale ML and AI system, with these results the Google Cloud and NOAA platforms would be used to execute full-sized prototypes which can help the results presented by NOAA systems with optimal efficiency. Further, this system aimed to achieve a significant hike in the ability of NOAA for leveraging an enormous diversity and volume of environmental data for enhancing prediction values.

A recent research carried out by Arcomano, T et al. [8] investigated the application of ML tools for predicting weather conditions by working on the computing-based, low-resolution model used for predicting global atmospheric conditions. The performance forecast from this model was compared to check its efficiency with the persistence, daily climatology, and numeric result values measured on similar prognostic state resolution and variables. A twenty-day forecast recorded on an hourly basis with the realistic values of the model predicted on the variables of atmospheric state on all forecast time for the whole world. The Machine Learning model proves better results in terms of both persistence and climatology in the first three days of testing in midlatitude regions, however, did not prove optimal results in tropical areas. When compared with the numerical model, the Machine Learning presented in their research performed better for state variables affected mostly by the parameterized methods in a numerical method. The authors detailed an ML parallel RC-based model used for predicting the state of the global atmosphere in a similar gridded format as the physics-based numerical model to predict global weather, resulting in realistic values. The three-day testing timeline can also be extended to reduce or eliminate the over-predicting atmospheric spatial variability on a larger scale. Forecasting variables proven to be the best, used in this model in comparison with the physics-based numerical model of prognostic identical state resolution and variables are the ones that are affected most by this process. The results achieved suggest that the model holds potential for short-term forecasting, and can be adapted easily to higher resolution using a bigger-scaled supercomputer because of its highly scalable parallel computing algorithm. Concerning the wall-clock time, their algorithm proved to be highly efficient, it also holds an application for rapid prediction of the weather forecast and can also be applied in limited area settings if not on global ones. The future applications of the ML model could also be used in dynamical and geophysical fluid systems.

Schürholz D. et al. [9] presented research that detailed an AI-enabled context-aware prediction system for air quality in smart cities. Metropolitan cities no matter the country, developed or under-developed, are experiencing a rapid increase in the level of air pollution because of numerous anthropogenic reasons, resulting in accurate prediction of air quality an important task to maintain public health. Their research however included an important statement, that even though there have been numerous researches conducted and modeled on this topic, not much of the researchers talk about the effect of

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pollution on individual people. Which came up with a motivation for this research in terms of prediction methods using the concepts of context-aware computing, hence resulting in an algorithm of predicting accurate air quality (Deep Neural Network short-term memory device) with data from all surrounding sources (traffic volumes, bushfire incidents) and the health profile of the user. A tool named MyAQI (My Air Quality Index) was integrated with their model, further evaluating and implemented in real-time terms specifically for the case of Victoria, Australia (Urban Area). The outcomes of their experiment are stated as (a) 90-96% of the high level of precisions rates were achieved when the air quality was forecasted in four monitoring stations. (b) this model had high adaptability for users with individual conditions of health and how they are affected by different levels of pollutants present in the air. The prediction accuracy noticed for some of the monitoring stations was nearly 3%. As per the localized AQ nature, a balance was considered for both short-term and long-term sources of pollution which result in low-frequency of pollution (high-peak), and are quite hard for prediction, and also results in a requirement for a Robust, predicting Machine Learning Algorithm. As per the impact of a sustainability framework for solutions, the benefits and effects of their research model were found in 5 main areas: Persons with different health issues, communities, environment, technical and economic.

Liu Y., et al. [10] presented an algorithm to monitor the remote sensing data on Air Pollution with the help of AI tools. The authors realized that the present state-of-art methods take a longer time for monitoring the data from the environment, and the coefficients achieved are small in range. Another thing noted from these earlier algorithms was that the rate of error was high, and the efficiency of monitoring is also low. Their research was centered on the general theory of analyzing the transmission of atmospheric radiation using the transmission model for electromagnetic radiation; and atmospheric radiation; parallel plane atmospheric radiation theory; Beer–Bouguer–Lambert law; and the transfer equation. All these models were used to construct simultaneous equations using the data from remote sensing multi-band satellites. This data can be anything from aerosol turbidity to the pixel information from the images estimated by decomposition of the equations using the pixel data. Their model helped in offering higher accuracy of monitoring, wider range, and also higher efficiency.

M. Nargotra and M. J. Khurjekar, [11] presented a Green House model based on the AI and IoT tools, using communication module (ESP8266), environment monitoring sensors, native microcontroller (LPC2138), following the design of the server considering the real-time forecast of climate data and analyzing this data for deciding the irrigation practices, it is done to achieve high automation of the system. Level-3 deployment of IoT, wrong forecast of weather data, real-time counteraction with intelligent and automated control of using and optimizing water needs hence resulting in uniform yields. This optimization of water needs depends on the requirements of the plants instead of the assumption of a farmer, this is done by using static information like the type of soil, type of plant or crops planted as well as the dynamic data from the environment collected with the help of sensors. The data used by the authors also was tested for other algorithms like SMO (SVM), C4.5, and Naïve Bayes. Their model also included the creation of a web page for easy monitoring of the green-house data. As a result, it was realized that attributes that hold an important role to predict the water needs were dependent on each other's, therefore when using a particular algorithm these dependency factors were also considered. Due to this dependence, the Naïve Bayes algorithm was eliminated as this only assumes the independence of inputs inherently. Considering that these metrics were obtained for a limited data set only, the outcomes for larger data set may slightly differ, hence making SMO a better algorithm for classification as both memory and speed required are high when using larger data sets. Hence is was noted that for unbalance training of data sets the SVM (SMO) produced better results as compared to the J48.

A. Pandey et al., [12] came up with a machine to control pollution using the ML and AI tools. Research and studies conducted on the ever-increasing pollution are going on since last many years and there have been numerous advantages noted on controlling and conserving the pollution. The authors were also motivated by some of the main state-of-art studies and for the aspects of humanity to come up with a machine that will both control the pollution levels and convert the pollutant into a power supply for this machine. Their machine was architect similar to the pole of traffic lights, with numerous hardware devices connected to it, like a converter cum inverter and an Electrostatic precipitator used to synthesize the pollutants. The next part is carried out by the computing and information technologies like Cloud Computing, IoT, Deep Neural Networks, Reinforcement Learning, Computational Logic, and mainly Artificial Intelligence as all these technologies are related with one another used to facilitate an overall working of the model efficiently. This research was based only on a survey and only a proposal was presented for controlling pollution, as it is no secret that with higher pollution comes more and more health risks. The researchers faced many problems while carrying out this research which could be improved with better outcomes. A $4m^3$ open area was used for testing containing approximately 5 Kg of air as per the Mole Concept, and further, a $70m^3$ of the air was taken using a fan that is, $70 \times 1.225 = 85.75$ kg/minute and approximately 1.5Kg/sec. Afterward, 1.5Kg of polluted air was taken out of 5Kg air which was sent to filter. As an outcome nearly 20gm of carbon elements and 500gm/sec of filtered air was received, the authors also presented the output data using graphs.

Brevini B. [13] with research titled "Black boxes, not green" detailed the omitting levels of environment and mythological tools of Artificial Intelligence. Daily we read or use at least a single technology working on Artificial

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Intelligence tools, which also helps to solve the biggest world problems, from the reduction of fatalities in accidents to treating diseases to anticipating threats related to cybersecurity, and mainly fighting climate change. The authors argue that Artificial Intelligence runs of machines, infrastructure as well as technology which depletes the scarce resources in its consumption, production, and disposal hence increasing the used amount of energy, and exacerbate the problems of both pollution and waste. This also depends on the data centers which require higher amounts of energy for just analyzing and computing purposes. Hence in attempts of reducing climate change, we must also consider the environmental issues which are generated when using AI, as it involves more and more capabilities of computing instruments, estimating the carbon footprints involved in disclosing and computing information: all this amounting to be the first step adopted in the right direction. One of the solutions can be presenting a transparent count of the involved carbon footprints of devices powered by AI in a "Tech Carbon Footprint Label" form just for raising awareness and adequately informing the public and the regulators regarding adoption implications of every smart technology used.

Gaya M. S. et al., [14] in the latest research conducted on estimating the index of water quality using the tools of Artificial Intelligence and multi-linear regression analysis. A certain location for some time helps in estimating the measure of water quality index. Higher index values show that the ware is not safe for drinking and is not adequate in terms of quality to meet the requirement of designated uses. The various classical methods presented in the research are not reliable to produce promising forecasting results. The authors presented research using AI and MLR tools as a classical linear model to estimate WQI for the Yamuna river, Palla station in India. The river's full-scale data was involved in validating this technique. DC: Determination Coefficient, RMSE: Root Mean Squared Error, and MSE: Mean Square Error are the performance measures used for estimating the performance and accuracy of this model. The outcomes presented in the research show that the AI models used with the ANFIs method are better than the MLR employed models up to 10% in a verification phase. The major difference between the ANFIS and ANN accuracy is negligible because of a slight increase in the performance which indicates that both these techniques are highly reliable to estimate the Water Quality Index. The models make use of the water quality variables in terms of input where the results obtained indicate that AI helped in accurately estimating the trajectories of the water quality index observed. Their models are highly reliable in terms of predicting the index of water quality in rivers.

In similar research conducted by Bangia A. [15] also estimated the water quality using the conjunction of AI and Wavelet Decomposition. There is no denying the fact that the survival of earth is not possible without one of the important resources that are water. In the present technologically advanced world, with more and more devices developed for making our life comfortable and easy, and still not technology and application of Artificial Intelligence can never replace or replicate the requirement of water on earth. Their research includes qualitative exploration of components of water components such as, DO: Dissolved Oxygen, BOD: Biochemical Oxygen Demand, COD: Chemical Oxygen Demand; and pH: potential of Hydrogen. This research was also conducted on the Yamuna river in various sample locations. This sample was designated for the pollutant reported majorly in the region with the help of Artificial Intelligence using LSSVR: "Least Squares Support Vector Regression" and the hybrid of LSSVR and wavelet decomposition. It was noticed that the hybrid of wavelet and LSSVR forming WLSSVR, helped in predicting accurate quality among the 2 prototypes simulated depending on the simulation errors that are R2: the determination coefficient, MAE: Mean Absolute Error, RMSE: Root–Mean-Square Error as well as the time of execution for both prototypes. The overall value of RMSE decreases the training and validation using WLSSVR in comparison to the LSSVR model. Further, a lesser decrease in MAE and RMSE values was observed and MAE on average terms showed less variability and R2 has a higher variability according to the simulations. The patterns observed from this research can help in predicting the parameters of water quality in the future so that it can prohibit the future decrease in water quality that can prove to be lethal if continued.

Cole M. A. et al. [16] used the approach of Augmented Synthetic Control with Machine Learning methods to describe the effects of Lockdown due to Covid-2019 on health due to a decrease in Air Pollution. The authors followed a two-step approach to quantify four different kinds of air pollutants present in the air. Machine Learning was applied to remove the confounding impacts of weather conditions on the concentration of pollution. The second step in the approach was to use augmented synthetic control for estimating the effects of lockdown on normalized pollution levels related to the control group cities which were not under lockdown. It was discovered that the concentrations of Nitrogen Dioxide present in the atmosphere have decreased by 24μg/m^3 and PM10 concentration is also lowered but for some time only. Whereas no effect was noticed in the levels of CO or SO_2. The higher percentage of NO_2 present in the atmosphere results in a total of 10,825 deaths in China Annually. The results of this research show that the effect of lockdown in terms of the pollutants, which the reports published in newspapers have failed to mention about clean-environment owing to lockdown. Another fact presented in the study was that the concentration of Nitrogen Dioxide is an air pollutant that is tied closely to the usage of fossil fuel and exhaust from traffic volumes. In lockdown affective in Wuhan, this concentration was decreased by 63%, and by the end of a 12-day analysis window, the level was also further reduced to 16μg/m^3. Despite the difficulties, if estimating the cost-saving from any reduction in emissions, the objective of this research was to show that policies like lock-down has far-reaching implications that can also extend to the primary aim of promoting better health.

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Said M. I. M. [17] followed the approach of Artificial Intelligence to predict the quality of river water. However, this paper was a review conducted on numerous state-of-art methods conducted, the paper helped in presenting an overview of Artificial Intelligence methods used. An accurate prediction of water quality can help in providing a direction in early warning of pollution in river water and can help the policymakers for managing the water resources more efficiently. The early predictions can help in revealing the proclivity of the aspects of water quality as per the latest transformation, shifting, and water quality rules about the pollutant in a watershed. Predictive capabilities of standard methods were constrained because of the non-linear, non-stationary, inaccuracy, uncertainty, complexity, and the variable interaction of the parameters of water quality. Since the 20th century, the AI approaches were found to be highly effective in improving, complementing deficiencies, simulating, and bridging gaps, in the precision of predictive models concerning the multiple evaluation measures to design, deploy, handle and plan the multiple engineering systems effectively. The review also discussed the novel methods of using AI and knowledge-based systems to implement the prediction and modelling of water quality measures effectively. It is important to select a suitable model in all of the future prediction models so that proper measures can be followed for preventing further river water pollution. Hence, incorporating the present heuristic model with the intellectual and model manipulation of calibrating the parameter can be instrumental. The latest development in the technology of AI offers a way of filling a bridge among the professionals and designers working on such models. AI approaches could also help novice users in assessing if the produced digital models by the functioning modelling are phenomenal. Several plans are being submitted and investigated for further advancements as well as their potential in terms of usage. More progress in function modelling in the direction of the AI integrated model is expected to be promising.

Tung and Yaseen [18] also conducted a review study on analysing the different modelling AI methods to check the quality of river water spanning from the year 2000 till 2020. Through this survey, it was rightly stated by the authors that there is an increasing and unsettling rise of contamination in the freshwater reserved due to anthropogenic activities and climate change. Earlier the studies were conducted to detect contamination were only limited to the numbers of risk assessment and WQ prediction, depending on the techniques of classifying the pollutants and designing early warning systems. Currently, the main challenge is to deal with data related to water quality, as it is problematic to handle because of its non-stationary and non-linearity feature, along with its vague properties because of its interdependent relationship, unpredictable natural variations along its complex nature. Their survey covered generalization regional investigation, performance metrics, input variability, model structure, and comprehensively assessing the progress of AI models in accessing the quality of river water. The deficient data, lack of funding, increasing contaminants, are the main motivation factors of using AI models which can enable the integration of white-box or black-box models, along with other benchmarked models to promote the research of detecting climate change using intelligent computing methods. Nearly 200 different research were considered by the authors, categorizing the research into two parts. First, assessing all the individual models describing the unique nature derived from a bibliographic review. Traditional methods were not successful in filling the gaps to full aspects of non-stationary, uncertain, non-linear, and noisy data as compared to the hybrid methods. The second part considered the limitations of every model and the main findings of the study; the most explored rivers were tracked out; most commonly used output models were listed; the selected time-step was given attention, and lastly, performance metrics chosen were also discussed. From all the papers it was noticed that data of water quality indexing, system accuracy, and other performance indices can increase the acceptability of AI models in real-life applications.

Luccioni A., et al., [19] carried out interesting research using AI models to visualize the effects of climate change through images. The real-time application of their project aimed at raising better understanding and public awareness of climate change and inspiring people to question their lifestyle choices. Images generated through Artificial intelligence methods helped in tracing the street-level effects of climate change. The research was cantered in the Quebec region of Canada, an area frequently affected by floods due to climate change. For generating images of locations that were affected the most, a custom Generative Adversarial Network was generated. A GAN model is a network comprising of two elements, a generator, and a discriminator. The generator aims on fooling the discriminator by creating images that would appear realistic, and the discriminator attempts on distinguishing those images from the real images (training set). In their model, the generator was set up to distinguish whether the images created by the generator are actual images of a flood. The process goes on with the generator improving the quality of its images to make the discriminator, point out fewer and fewer images. The model involves the usage of convergence where the images created are indistinguishable from the real images. These generated images were simply used to change the perception of people towards climate change. The authors are also attempting to create a website for hosting their AI models, providing a seamless user experience for everyone, to better explain the phenomenon of prediction and apply the usage of AI models and its feature into real-time usage.

Narayan, Y [20] came up with a concept of DeepWaste, using Artificial Intelligence to classify the different waste materials to fight against climate change. When waste materials that are easily recyclable end up being landfills, they emit potent greenhouse gasses which emit into our environment. The present methods of waste disposal are confusing,

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not efficient, and inaccurate. The author created an AI-enabled mobile application called DeepWaste to provide the users with an instantaneous classification system of waste to categorize it into compost, recyclable, or just trash. Simple CNN model was a user for classifying among the different waste items using a 50-layer network and inputting real-time images. Currently, the first-ever application made for waste classification can help people in thinking over their lifestyle choice in case they are producing more trash than recyclable waste. The authors also stated that even if using DeepWaste helps in reducing just 1% of the waste disposal, it will be equivalent to removing nearly 6.5 million gas-burning vehicles off the road, demonstrating the potential of ML techniques for tackling the grievous issue of climate change.

III. CONCLUSION

The involvement of Artificial Intelligent and Machine Learning in areas like climate change has been going on since its inception. But to physically check its usage has not been easy. It is important to answer the question, of these technological advancements can help in tackling the issue of climate change? Or is this all just another scam. The review conducted in this paper aimed at checking the efficiency of these methods both in real-time and theoretical terms. From all the reviews one thing became clear, is that many ML and AI methods are applied in the field, whether it is for feature extraction, dimensionality reduction, or for recreating the lost or unavailable data. Overall, the review attempted to summarize the many Artificial Intelligent methods applied in big-budget projects and in small-scale theoretical methods to check their efficiency and application in waste reduction, checking water quality of rivers, preparedness for floods, synthetic pollution control, and other climate concerns. It was also discovered that fewer applications have been found associated with AI due to its expensive nature, requires validation, and is complicated to use. However, when applied to the social causes can give extraordinary outcomes, can help in making people aware of the importance, of caring for our rapidly changing environment.

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