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Artificial Intelligence for Better Climate Governance

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Abstract: *The world's attention today is on climate change that is no more just a perceived risk. Climate change is already impacting livelihoods and by impacting the vulnerable regions and the communities more than others, may also be aggravating economic and social inequalities. Effective climate governance, therefore, requires better data collation and analysis thereof. Early warning signals of the impending change must not only be received but also distributed through strong institutional frameworks. While significant progress is evident in this direction, the limitations of those in charge of governance have also been evident. Due to this, increasingly, there is a trend of inter-governmental and inter-organizational partnerships along with higher engagement of communities to better adapt to climate change. While mitigation of climate change has largely rested with the governments; communities and the private sector, in general, have been more suited to assess the appropriate scale and timing of projects at the local level. The future, though, with more aggressive climate changes, may not allow such a neat categorization. As local actors will have to learn to not only to adapt but also mitigate climate changes, they will need better tools such as artificial intelligence (AI). Governments, too, will need to embed artificial intelligence in all climate-related policy-making. But care has to be taken to ensure that the access to AI and the benefits thereof are equitably distributed to prevent aggravation of inequalities across regions and across nations.*

Keywords: *Climate Change, Climate Governance, Artificial Intelligence*

1. Introduction

Artificial intelligence (AI) has pervaded our everyday life. Businesses have woken up to this reality and are grasping to leverage on to its capabilities. The power of AI is growing at a geometric rate. Google has already launched Projects like Raspberry Pi to create a software to create AI. It seems machines will create AI much more rapidly than humans when fitted with a software of their own. Even currently, the combination of Big Data and AI is proving to be a mighty force. The data output is becoming so massive that even the analysis of that requires AI. Besides, AI can provide much deeper perspectives through pattern recognition and self-learning of algorithms. Equity markets have already witnessed High Frequency Trading (HFT) or algorithmic trading. Some experts are of the view that the increasing volatility in equity markets is a result of algorithmic trading. Nonetheless, speed alone may not be the distinguishing characteristic of algorithmic trading – when combined with AI, deeper insights are likely to be generated. From descriptive to predictive to now cognitive power of machines by which they are moving away from mere predictions to creating the desired conditions, the possibilities in each sphere have expanded both vertically and horizontally. The health care industry is one of the big users of AI enabling it to not just predict the health conditions of patients into the future but rather pick alternative right solutions from the diagnosis, all available literature and patient health records. AI is, thus, transcending the knowledge base of the doctors and nurses. Many say that AI will be able to provide pre-primary care and, thereby, lessen the burden on overloaded hospitals. That is why, investment in AI has accelerated from $282 million in 2011 to $2.4 billion in 2015, a 746% increase in five years. In 2016, this continued to increase with roughly another $1.5 billion being invested in more than 200 AI-focused companies in 2016.

2. Artificial Intelligence and Business Process Efficiencies

AI applications are increasingly been deployed for industrial, government and consumer purposes and over the years, the breadth of applications has expanded many times over. Neuroscience and AI experts have taken inspiration from the human brain in creating a new "deep learning" method that enables computers to learn about the visual world largely on their own which can assist the world in solving its complex problems. Climate change is not a distant problem any longer as we are experiencing it in our lifetime. Analysts are of the view that many problems faced by humanity may be linked to the problem of climate change itself. Rising temperatures have caused a lot of ecological imbalance resulting in unprecedented storms, tsunamis, forest fires and destruction of some species altogether. Similarly, many of the diseases including tuberculosis, cancer, dengue, etc. are being linked to climate change. Today, national and international efforts are going on for reduction of greenhouse gases (GHGs).

Apart from moving away from fossil-based energy generation and curbing deforestation, a lot of corporate-level research is being undertaken to improve efficiencies in business processes. Such efficiencies serve to reduce GHGs through decline in consumption of resources.Business process outsourcing is no more an option as it used to be for cost reduction. It is said that the next wave of cost reduction through reduced consumption of resources will come from AI. AI is already being employed to read unstructured data from different sources, find important information and make conclusions. Businesses have been focusing on business process efficiencies towards improving productivities and, thereby, the consumption of resources. Indirect emissions of GHGs is sought to be reduced through reduction of GHG at the suppliers' end. Improvements in the physical and financial supply chains have been the focus of many businesses in the last decade with noticeable positive results. Adam Sadilek et al (2016) in their study on foodborne illnesses concluded that the adaptive inspection process through AI is 64 per cent more effective at identifying problematic venues as compared to the traditional inspection process based on sampling technique. This ability to read unstructured data and make sense out of it is especially helpful in several business processes such as management of accounts receivables or accounts payables. A good accounts receivables management system means ability to assess the appropriate credit terms for individual customers based on their past transaction history in their business dealings, gather timely information on their ability to make payments on time and send them timely reminders.Currently, most companies have standardized credit terms for their customers that may impact long-term customer relationship management.

AI has entered the human resources field as well. Key HR functions such as HR Operations, Talent Acquisition and Talent Development are getting assisted through intelligent assistants known as chatbots or computer algorithms designed to simulate a human conversation, to recruit employees, answer HR questions or personalize learning experiences. Just as marketers have discovered the power of chatbots to personalize a shopping experience, HR leaders are starting to pilot chatbots to transform the employee experience. Similarly, other business processes are getting transformed by AI and leading to greater speed, cost reductions and reduction in GHGs.

3. Problem of Adaptation to Climate Change

But climate change problem is also a problem of adaptation. It has been noted that some sections of society have been found to be more vulnerable to climate change effects than others. The poor, particularly, have low adaptive capacity due to low access to resources and information. Similarly, people living along the coast are vulnerable to hurricanes, storms, etc. The situation has been grave enough for international bodies like the United Nations Framework Convention on Climate Change (UNFCCC) to insist on member countries' commitments for greenhouse gas reductions. At the Paris summit, each country submitted its intended nationally determined contributions (INDCs) towards the reduction of GHGs. What was noticeable was that even the developing countries, unlike, previous conventions, submitted their commitments. Yet, it remains certain that the earth's temperatures will continue to rise. That is why, even the goal at Paris was simply to contain the rise in temperature to 2 degrees centigrade, although the desirable target expressed was 1.5 degrees centigrade.

Climate change can have significant impact across all infrastructure sectors. Asset damage/deterioration, increase in operating expenditure, increase in capital expenditure, changes in market demand for services, increased insurance cost or lack of insurance availability have all been identified as significant impact of climate change. Figure 1 gives examples of vulnerabilities in different sectors like water, energy, transport etc., the possible impact and the resilience measures that can be taken to meet the objective of climate proofing.

Type of water services	Changes in climate	Possible impacts	Example resilience-building measures
Municipal and industrial water supply	Changes in precipitation patterns and quantities	Reduction in water availability, quality and security	Implement water use efficiency measures
Wastewater and urban storm water	More frequent heavy rainfall	Overload capacity of sewer systems and water and wastewater treatment plants	Increase capacity of drainage channels
	Periods of lower rainfall	Resulting lower flows lead to higher pollutant concentrations	Implement pollution warning system
Irrigation	Higher temperatures and levels of evapotranspiration	Greater demand for irrigation	Expand use of drip irrigation systems
	Increased variability in rainfall leading to reduced water availability	Increased pressure on existing sources of water for irrigation e.g. rivers and aquifers	Improve water efficiency

Type of generation/ distribution	Changes in climate	Possible impacts	Example resilience-building measures
Hydropower	Increase/ decrease in average water availability	Increased/ reduced power output Increased competition with other water users.	Schedule release to optimize income
	Increasing air temperatures and evaporative losses	Reduction in available generation capacity requiring changes in operational procedure	Schedule release to optimize income
	Changes in precipitation and/or decreasing snowpack	Reduction in available generation capacity requiring changes in operational procedure	Adjust water management
	Increasing intensity and frequency of extreme precipitation events and flooding	Increased risk of physical damage e.g. by debris carried from flooded areas, damage to dams and turbines, lost output due to releasing water through bypass channels Increased sedimentation of hydropower reservoirs	Increase storage capacity

Type of transport	Changes in climate	Possible impacts	Example resilience-building measures
Road	Increases in very hot days and heat waves	Deterioration of road surface integrity e.g. through softening and traffic-related rutting. Thermal expansion of bridge joints and paved surfaces.	Enhance design criteria to withstand extreme heat
	Increases in temperature in very cold regions	Changes in road subsidence and weakening of bridge supports due to thawing of permafrost	Enhance design criteria to withstand permafrost thaw
	Sea level rise and storm surges	Damage to highways, roads, underground tunnels and bridges due to flooding, inundation of coastal areas and coastal erosion	Update site selection criteria
	Increase in intense precipitation events	Damage to road infrastructure due to landslides Overloading of drainage systems leading to surface water flooding	Improve emergency repair procedures Upgrade drainage systems
	Increased drought	Damage to road infrastructure due to increased susceptibility to wildfires	Install fire barriers beside roads

Fig. 1: Examples of Climate Change Vulnerabilities and Resilience Measures

Source: PPPIAF, World Bank Group, January 2016

4. Artificial Intelligence in Climate Change Adaptive Measures

Now, studying the possible impact and instituting the appropriate resilience measure will be facilitated greatly through the use of artificial intelligence. Already, in some parts of the world AI technologies are being employed towards the adaptive measures listed in the above table. For example, Jackson Electric Authority (JEA) in Florida, USA installed a real time system by the name of Optimized System Controls of Aquifer Resources or OSCAR to control the water system in real time, creating what JEA refers to as Operations Optimization. This means the water system is monitored, regulated and adjusted every minute of the day throughout the year, creating a 'just in time' water supply. OSCAR regulates the pumping of water from the aquifer by evaluating data from a variety of sources. System Control and Data Acquisition (SCADA) is key to the optimization of this process. The data extracted from SCADA have enabled JEA to move from reactive to proactive process based on consumption forecasting. Earlier, when demand was high, wells were drawn down over time to levels that reduced their life. Pumps required frequent maintenance and used excessive energy as they switched off and on almost constantly. Actual system conditions are compared to forecasts and operators are forewarned of any impending significant variation or equipment failure. JEA is believed to be the first to use such a system. Real time control software for water efficiency is now being increasingly employed in other organizations as well minimizing energy consumption and maximizing water generation. This ability to compare all these variables with such frequency and accuracy far surpasses human intelligence. Start-ups like EMAGIN are also working in this direction, shifting the paradigm from reacting manually to proactively controlling how water utilities are operated and managed. Heuristic algorithms are generated to forecast values based on historical water consumption data as well as weather-related data and pumping is assigned to the water plant closest in proximity to the need, augmented by plants at a distance only when necessary to meet demand. As pumping is scheduled ahead of time and is scheduled for times of day when energy costs are lower, there are huge energy efficiencies as well in addition to water efficiencies. Besides, chemical costs for treating water are minimized because water is treated as it is needed. And due to better use of the asset and lower salt intrusion, the capital cost and maintenance costs are minimized.

Similarly, in Australia, artificial neural networks (ANNs) have been used to quantify the spatial distribution of channel seepage and identify the leakiest parts or 'hotspots' of the channel system requiring intervention. Such interventions are necessary in drought-affected areas or areas facing irrigation-induced salinity concerns. Hongwu Tang et al (2010) have also reported the employment of the artificial neural network model to develop sluice gate operation procedures of the channel network in Pudong New District, Shanghai according to the water levels in both the outer and inner rivers. The Study's analysis concludes that the modelling system satisfactorily meets the demands for sluice gate operation and water resources optimization management of the channel network and thus provides decision-making support for integrated management of water resources. Another neural network judgement model has been described in the study of In-Sung Yeon et al (2005) that warns of possible pollution accident in Korea. The water quality forecasting model is linked to the runoff forecasting model and joined with the judgement model to warn of the possible pollution accident, which completes the artificial intelligence warning system. Estimation results using Graphic User Interface (GUI) verify that the artificial warning system can be a reasonable judgement of the water pollution data.

Robotics and precision agriculture are also providing producers with powerful tools in order to improve the competitiveness of their farms. Agricultural researchers from the Agricultural Robotics Laboratory of the UPV and computer scientists are working on the development of an unmanned robot, equipped with non-invasive advanced sensors and AI systems, which will help manage vineyards. This robot will provide reliable, fast and objective information on the state of the vineyards to grape growers, such as vegetative development, water status, production and grape composition.

Another effective application of AI has been in streamlining disaster response which is a key climate adaptation measure. Projects such as the Orchid project combine human and AI into a complementary unit known as a Human Agent Collective (HAC) to assume tasks such as directing surveillance drones, resource management and search planning. Similar is the application of AI in infrastructure management. Salini (2010) described the computation of the Road Global Value Index (RGVI) to study and predict the pavement condition, the traffic and the economic and political importance for each and every road section using neural networks including some important innovations such as the consideration of variables without data or even totally unknown variables. Genetic algorithms (GA), capable of optimizing problems through mimicking the natural selection and natural genetics and thus identifying the best solution in pavement management. Future funding requirements are also estimated depending on future asset conditions estimated through the use of such models.

5. Climate Change Vulnerabilities – Role of Local Institutions and Social Practices

It is well appreciated in climate circles that it is important to mainstream climate change adaptation into development planning across sectors and that response-driven adaptation is not sufficient. That is why, all countries need to learn from the experiences of other national and sub-national governments in designing appropriate cost-effective and inclusive planning and response systems. The guiding principles for climate change adaptation also recognize that it is vital to extend beyond technical and engineering adaptation and incorporate the social and economic measures and traditional knowledge to find long-term solutions to increasing resilience of both people and infrastructure. All multilateral development banks nowadays create tools to climate-proof investments and mainstream climate change adaptation into development. The African Development Bank, for example, has created a climate safeguard system whereby it categorizes all projects into three categories: Category I contains all projects that are very vulnerable to climate change and thereby require a detailed evaluation of climate change risks and adaptation measures; in category II are projects that are vulnerable to climate change but the degree of vulnerability is lower required a less detailed evaluation or a review of climate change risks and adaptation measures and category III contains projects that are not vulnerable to climate risk and, therefore, a voluntary consideration of low cost risk management and adaptation measures may be the only recommendation.

Certainly, local institutions play a vital role in designing appropriate adaptation measures. These institutions include local public institutions, civil society institutions such as rural producers' organization, cooperatives, savings and loan groups etc. and private institutions such as NGOs and charities. As observed in the World Bank paper of July 2008, costs of adaptation include monetary costs, household labor requirements, household training requirements, required help from community, required help from institutions like NGOs or local authorities as well as monetary costs incurred by institutions.

The costs of adaptation decline significantly when sound social support systems are in place. In Ethiopia, for example, as documented in the study by Khan, S. et al (2009), the buusa gonnofa is a key social support system in Borana culture, wherein people who have lost their cattle to drought or to raiding are gifted cattle by other wealthy clan members temporarily to ride over rough times and not face any milk shortage. This is an important social safety net whose strength depends on the kinship networks who have at least some members who are relatively wealthy. That is why external interventions to grow the networks and make them more robust are generally sought after. However, these external actors will also have to thoroughly understand the social dynamics before suggesting any solution. Otherwise, there is risk of maladaptation through selection of projects that lock people into unsustainable practices. As noted in the paper by Lindsey Jones (2015), poor use of climate information in the design of urban infrastructure or cultural marginalization of vulnerable groups is a common cause of maladaptation. Another reason is the inadequate understanding of climate risks as they evolve over time. Poorly implemented adaptation strategies also often lead to inequitable distribution of adaptation benefits. And finally, maladaptation occurs when short-term costs or benefits out-weigh long-term costs or benefits. Community networks and action groups thriving on trustworthiness, collective action and linkages to community resources serve to prevent or reduce the ill-effects of maladaptation. Local institutions that promote these networks and connect with their decision-takers play a larger and more effective role in climate adaptation. For example, a local NGO in touch with sub-Saharan subsistence farmers in Africa may connect them to farmers and NGOs in Europe to provide them with drought-resistant seeds. Growing the networks across different nations will be important for the success of such institutions. And here is where AI can accelerate the process through identification of appropriate partners.

Bankers, too, can help as their adoption of technology and AI is growing really fast. According to the Accenture report 'Technology for People', nearly 80 per cent of bankers believe that AI will enable simpler user interfaces that will help banks create a more human-like customer experience. In addition, they also believe that AI will revolutionize the way banks gather information and interact with customers. Bankers must, thereby, design technology to help align their products and services with what consumers want in near real-time. In traditional banks, basic transactions continue to migrate from physical to digital channels, giving sufficient opportunity to bankers to observe minutely consumer behaviour and design products for unique customer experiences. The quality of such personalized experiences will determine customer satisfaction and, in turn, the ability of bankers to be significant network players. Another institution that will undergo a big change is the insurance industry. Insurers have begun investing in AI to empower agents, brokers and employees to enhance the customer experience with automated personalized services, faster claims handling and individual risk-based underwriting processes, according to Accenture's Technology Vision for 2017.

A well-established emissions trading system and supporting legislation on reducing GHGs has also been considered crucial in climate adaptation. There is now increasing collaboration for facilitating carbon trading. Another system that is showing promising results in USA particularly, is the system of issue of Renewable Energy Certificates (RECs). Unlike the first system by which the polluters can simply purchase the carbon credits from other nations in possession of the same; in case of RECs, an entity in need of energy can purchase renewable energy through RECs issued to surplus renewable energy producers. This, therefore, brings down the level of pollution as non-producers of renewable energy are still able to get access to the same. But, it is important to note that the system of RECs is yielding results on account of supporting legislation. India too has begun the system of RECs and currently issues in two categories – solar and non-solar

6. Recommendations from the Study

The Study recommends that together with mainstreaming climate change in the development goals of policy-making at all levels of the government, artificial intelligence (AI) should also be integrated into the planning process. AI, though growing at a fierce pace, has not deeply penetrated the government processes. If business processes can become more efficient with the use of AI, government processes can also become much more cost-efficient. AI in government is more of an individual effort instead of a system-wide effort. The existing prescriptive and market-based targets for provincial governments that include targets on carbon emissions and transportation efficiency standards may be achieved with different degrees of employment of AI. Every ministry should study to what extent the integration of AI in the available set of tools will improve decision-making and increase probability of achievement of development goals and resilience towards changing climate. AI may be used at different stages of a project such as procurement, risk assessment, cost minimization, team-formation, quality-inspection etc. Surely, there will be costs and benefits of adopting AI at every stage. The number of scenarios for a project will increase substantially with different permutations and combinations of AI at different stages of a project. The project outcomes, of course, have to ensure achievement of social goals with increased climate change adaptability, particularly of vulnerable sections of society and/or mitigation of harmful substances in the production process. Future research in this area will be useful to both industry and government.

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