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Brief Review

Applying Artificial Intelligence (AI) for Mitigation Climate Change Consequences of the Natural Disasters

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Abstract: Climate change and weather-related disasters are speeded very fast in the last decades with the consequences bringing to humanity: insecurity, destructing the ecological systems, increasing poverty, human victims, and economical losses everywhere on the planet. The innovative methods applied to mitigate the magnitudes of natural disasters and to combat effectively their negative impact consist of remote and earth constantly monitoring, data collection, creation of models for big data extrapolation, prediction, in-time warning for prevention, and others. Artificial intelligence (AI) is used to deal with big data, for calculations, forecasts, predictions of natural disasters in the near future, the establishment of the possibilities to escape the hazards or risky situations, as well as to prepare the human being for adverse changes, and drawing the different choices as assistance the right decision to be accepted. Many projects, programs, and frameworks are adopted and carried out the separate governments and business makers to common goals and actions for the formation of a friendly environment and measures for reducing undesired climate alterations and cataclysms. The aim of the article is to review the last programs and innovations applied in the mitigation of climate change using AI.

Keywords: Weather-Related Disasters; Artificial Intelligence; Climate Change

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1. Sustainable development for the prosperity of the future generation

Since the 1972 UN Conference on Human Environment, or approximately half-century up to now as a result of discussions on environmental, social, and economic responsibilities confronted the world civilization, on 2015 UN Sustainable Development Summit has been taking the decision for the 2030 Agenda for Sustainable development and its 17 Sustainable Development Goals (SDGs). The five pillars (5Ps) of the 2030 Agenda or the core are five dimensions: *people, prosperity, planet, partnership, and peace* (Gupta & Vegelin 2016; Caiado et al. 2018; Polido et al. 2019).

Nevertheless, after a half-century, humanity is still far, far away from reaching the SDGs.

Let's look on the snapshots of nowadays, 2022 year: There is no peace on the globe; the old partnerships are broken; the planet is in danger from climate change; the prosperity is under doubt from the global lockdown of COVID-19 and its consequences; many people became victims or are in a not-safe mood for their future. Thus Sustainable development is still just a miracle or a big dream even with the all-new discoveries and technology that come way and are develop very fast. Over the last twenty years 90% of disasters have been caused by floods, storms, heat waves and other weather-related events (Wallemacq&Below 2015; Wahlström & Guha-Sapir 2015; Guha-Sapir et al. 2016).

The five countries most affected by disasters are the United States (472), China (441), India (288), Philippines (274), and Indonesia, (163) (Wahlström & Guha-Sapir 2015). Globally, nearly 60,000 people die each year as a result of disasters such as droughts, floods, earthquakes and tsunamis, and a further 150 million people are impacted by these events (Dutfield 2021). Between 1998 and 2017 climate and geophysical disasters killed over 1.3 million people and left a further 4.4 billion wounded, homeless, evacuated or in need of emergency support (Wallemacq & Rowena 2018).

Floods accounted about 47% of all weather-related disasters (1995-2015), affecting 2.3 billion people and killing 157,000. Storms are the deadliest type of weather-related disaster, accounting for 242,000 deaths or 40% of the global weather-related deaths, with 89% of these deaths occurring in lower-income countries. Heat waves accounted 148,000 of the 164,000 lives lost due to extreme temperatures, which mainly occurs in high-income countries (92%), with 90% for Europe. Africa is more than any other continent affected by drought; Emergency Events Database (EM-DAT) registered 136 events between 1995 and 2015, including 77 droughts in East Africa alone. The EM-DAT is a free database and holds over 20,000 worldwide data of natural and technological disasters from 1900 to the present day (Below 2016). The lack of data on indirect drought deaths is a weak point and new data gathering should be applied.

In 1988, the Centre for Research on the Epidemiology of Disasters (CRED) with the initial support of the World Health Organisation (WHO) and the Belgian Government created the Emergency Events Database (EM-DAT). The main objective of the database is to serve the purposes of humanitarian action at national and international levels with free access for non-commercial purposes. EM-DAT provides vulnerability assessments and rational decision-making in disaster situations (Below 2016).

Supportive Risk Awareness and Communication to Reduce impact of Cross-Border Heatwaves (SCORCH) is a EU funded project, from 2015, under the call by UNION CIVIL PROTECTION MECHANISM of Directorate General for European Civil Protection and Humanitarian Aid Operations (Topic: UCPM-2018-PP-PREV-AG; Grant Agreement Number: 826565; Shams & Hazel 2015). The heat waves, floods and storms are becoming increasingly frequent and severe in the last decades. Between 2005 and 2014, there were 335 natural disasters per year, this is an increase with 14% relating to the previous 10 years, and nearly double the level recorded from 1985 to 1994 (Myers 2016). No doubt that the humanity still cannot cope properly with the climate change, looking on cataclysms observed nowadays. Furthermore, the climate change effects are still unpredictable, despite implementation of novel methods and high technology, because they are running out of control. According to NASA, the upcoming climate change will bring a rise in numbers of severe droughts with longer durations, higher intensity of tropical storms and wildfires (https://climate.nasa.gov/effects/).

The article gives information about the different spheres of applying AI helping to prevent the disasters and mitigate the consequences; the aim is to inform and underline the importance of adequate ecology policy for sustainable development and to clarify the ecological problems in front of our civilization.

2. Methodology

The search was conducted using data base of Google and Google Scholar. The articles were chosen by similar title or keywords of interest. The next criterion was the data of publication, as mainly was looking for the last years of publication. The searches were conducted using the title of the article, titles of main sectors included in the paper, and different keywords. The keywords used in the search included: "AI", "sustainable development", "natural disaster management", "climate change", "natural disaster consequences", "AI and natural disaster prediction", "assessment", "climate change mitigation", "Emergency Events Database (EM-DAT)", "Supportive Risk Awareness and Communication to Reduce impact of Cross-Border Heatwaves (SCORCH)", "deep learning", and other.

3. Artificial Intelligence (AI) and mitigation of natural disaster consequences

AI can be powerful tool for mitigation the climate crisis through measurement, reduction, and removal of existing greenhouse and toxic emissions (GHG) from the atmosphere (Maher et al. 2022). The artificial Intelligence (AI) has a great potential to assess, predict, and mitigate the risk of climate change effects by the use of big data, applying learning algorithms, and sensing devices. AI performs fastly precise calculations and predictions for critical decisions, rendering how to diminish the impact and climate disasters destructive consequences (Huntingford et al. 2019; Xin et al. 2022; Linardos et al. 2022). For extremes such as droughts, AI can utilise model- and data-based ML to provide warnings and aid decision support (Huntingford et al. 2019). Table 1 gives the background for using AI to mitigate climate change (Maher et al. 2022).

Table 1. Framework for Using AI in Combating Climate Change (Maher et al. 2022)

<table>
<tr><th colspan="3">Mitigation</th><th colspan="2">Adaptation and Resilience</th><th>Fundamentals</th></tr>
<tr><th>Measurement</th><th>Reduction</th><th>Removal</th><th>Hazard Forecasting</th><th>Vulnerability and Exposure management</th><th>Climate research and modeling</th></tr>
<tr><td>Macro-level measurement e.g., estimating remote carbon natural stock</td><td>Reducing GHG emissions intensity e.g., supply forecasting for solar energy</td><td>Environmental removal e.g., monitoring encroachment on forests and other natural reserves</td><td>Projecting localized long-term trends e.g., regionalized modeling of sea-level rise or extreme events such as wildfires and floods</td><td>Managing crises e.g., monitoring epidemics</td><td>Climate research and modeling e.g., modeling of economic and social transition</td></tr>
<tr><td rowspan="3">Micro-level measurement e.g., calculating the carbon footprint of individual products</td><td>Improving energy efficiency e.g., encouraging behavioral change</td><td rowspan="3">Technological removal e.g., assessing carbon-capture storage sites</td><td rowspan="3">Building early warning systems e.g., near-term prediction of extreme events such as cyclones</td><td>Strengthening infrastructure e.g., intelligent irrigation</td><td>Climate finance e.g., forecasting carbon prices</td></tr>
<tr><td rowspan="2">Reducing greenhouse effects e.g., accelerating aerosol and chemistry research</td><td>Protecting populations e.g., predicting large-scale migration patterns</td><td rowspan="2">Education, nudging, and behavioral change e.g., recommendations for climate-friendly consumption</td></tr>
<tr><td>Preserving biodiversity e.g., identifying and counting species</td></tr>
</table>

The main uses for AI according Maher et al. (2022) are:

- **Gather, complete, and process data**
  - *Satellite and IoT data;*
  - *Filling gaps in temporally and spatially sparse data;*
- **Strengthen planning and decision making**
  - *Policy and climate-risk analytics;*
  - *Modeling of higher-order effects;*
  - *Bionic management;*

- **Optimize processes**
    - *Supply chain optimization;*
    - *Simulation environments;*
- **Support collaborative ecosystems**
    - *Vertical data sharing;*
    - *Enhanced communication tools;*
- **Encourage climatepositive behaviors**
    - *Climate-weighted suggestions;*
    - *Climate-friendly optimization functions.*

Luccioni et al. (2021) performed an approach with AI and big data flow and archive collections to create and imply a program (called "AI climate impact visualizer"), which allow following effects of climate changes as floods, storms, and wildfires to provide users with an AI-image visualization up to 2050. The simulations are accompanied with science information, regarding climate changes on a local and global scale. AI-amplified technologies are supported as a key solution to mitigate the accelerating climate change and its negative impact (Galaz et al. 2021).

The AI technology is much better than the human brain when carrying out certain tasks. The AI performance depends ordinary from quality data accessibility, Machine Learning (ML) and an appropriate architecture selection model. Through the development and implementation of advanced technical tools and approaches, such as satellites, drones, and remote sensing, using different networks, for instance, meteorological, hydrometeorological, and seismic, the global Earth data are growing fastly. In addition, the structural model designs are constantly being refined. Hence, the expectations are that ML will be prominent in disaster risk reduction (DRR) applications (Sun et al., 2020). For instance, a preliminary survey (2018–2021) literature shows that ML approaches are being used to improve early warning and alert systems and to generate hazard and susceptibility maps through ML-driven detection and forecasting of various natural threat types (Figure 1).

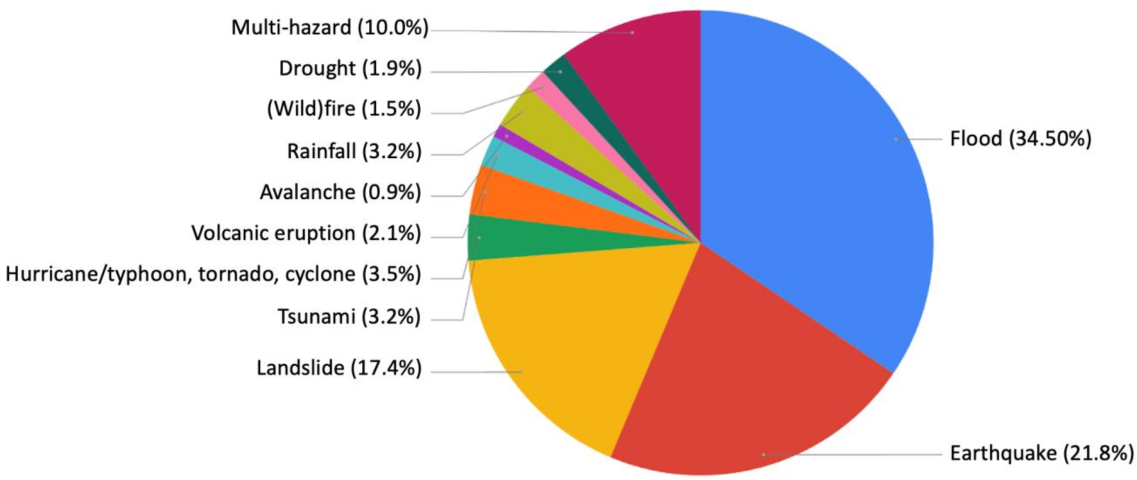

Figure 1. AI applications in detection and forecasting of natural hazards and disasters (2018-2021) (Kuglitsch et al. 2022).

Applications of AI in disaster management contain four phases: *mitigation, preparedness, response, and recovery*. According to the registered events the majority of AI applications address the **disaster response phase** (Sun et al., 2020). Detecting natural disasters with artificial intelligence (AI) is a promising way forward. Using AI for disaster management can save communities, lives and livelihoods. Currently, AI can predict four types of natural disasters: *earthquakes*; *volcanic eruptions*; *hurricanes and tornadoes* (Luciano 2018; Gupta&Roy 2020; Mittapalli et al. 2021; Kuglitsch et al. 2022).

- ***Earthquakes*** - researchers feed AI information systems with seismic imaging to train them. The AI analyses the data and learn about the patterns of various earthquakes and then can predict where an earthquake and aftershock might hit;
- ***Volcanic eruptions*** - researchers provide AI with seismic and geographical information, and they can get accurate predictions of future volcanic eruptions;
- ***Hurricanes and tornadoes*** - AI systems monitor satellite imagery, predict the course of a hurricane or tornado, and can determine the force of the storm.

The AI predicting natural disasters systems have limitations (Maher et al. 2022). Researchers are still trying to improve a way to predict flooding with AI by using rainfall records and flood simulations. Floods and other hydrological events affect more people globally than other natural disasters, but AI is still far from preventing flood-related crises (https://www.urinow.com/blog/ can-ai-predict-natural-disasters/).

In 2022 was created the Global Platform for DRR with the aim collaboration and *finding solutions to scale up climate*. According to the Mizutori, the head of United Nations Office for Disaster Risk Reduction (UNDRR), every US$1 investment in risk reduction and prevention save up about US$15 in post-disaster recovery. As well as, every US$1 investment in making disaster-resilient infrastructure saves US$4 from dealing with consequences and making reconstructions. The UNDRR gives unlimited information for the natural disasters by years and monitoring the Sendai Framework for Disaster Risk Reduction (https://www.undrr.org/about-undrr/our-work; UNDRR 2022).

4. Sendai Framework for Disaster Risk Reduction

Many reports inform for global warming and climate alterations, alerting humanity for soon unstoppable coming consequences. More than 55,000 people died during a heatwave in Russia (summer of 2010), Western and Southern Europe experienced major heatwaves in 2003 and 2006 which killed more than 72,000 and 3,400 people respectively. Europe witnessed a heatwave in summer 2015. Elsewhere, India recorded 2,500 lives lost in just one month between May and June, and Pakistan recorded 1,230 deaths from the same heatwave (Guha-Sapir et al. 2016; see Figure 2). On fig.2 are giving the events of natural disasters such as drought, floods, extreme weather, extreme temperature, landslides, dry mass movements, wildfires, volcanic activity, and earthquakes reported from the open data EM-DAT (2020).

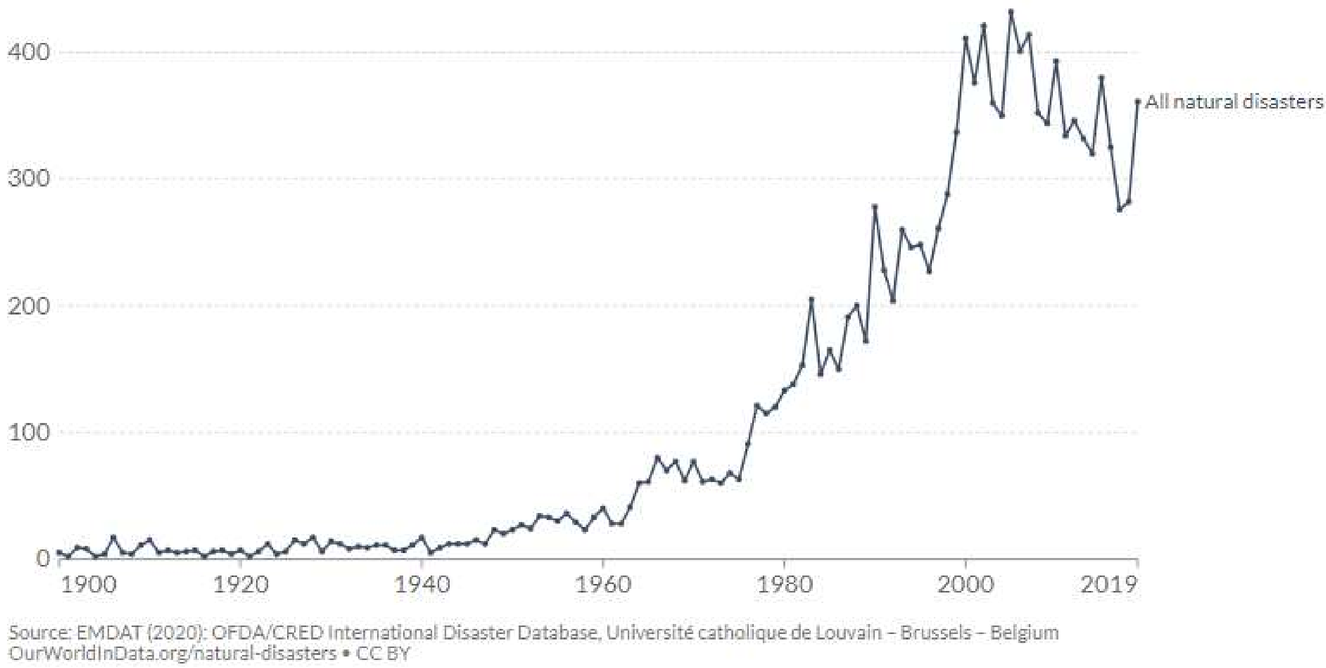

Figure 2. The number of global reported natural disaster events in any given year. Source: EMDAT (2020): OFDA/CRED International Disaster Database, Université catholique de Louvain - Brussels - Belgium. OurWorldInData.org/natural-disasters CC BY.

On 18 March 2015, member states of the United Nations (UN) adopted the Sendai Framework for Disaster Risk Reduction 2015–2030 (United Nations Office for Disaster Risk Reduction 2015) in Sendai, Japan, a city still recovering from the Great East Japan Earthquake and Tsunami (Mizutori 2020). The Sendai Framework's has seven bulls on drops of: *mortality*; *affected people; economic losses; damage of critical infrastructure; disruption of basic services*.

Moreover, Sendai Framework seeking for putting into practice of national and local disaster risk reduction strategies by 2020; cooperation between developing countries; increasing the early warning systems; and structures for disaster risk assessments and information (Wahlström & Guha-Sapir 2015). The Sendai Framework recommends comparing disaster losses between 2005 and 2015 with 2015 and 2030 (Mizutori 2020).

The Sendai Framework is the inheritor of the Hyogo Framework for Action (HFA) 2005-2015: "Building the Resilience of Nations and Communities to Disasters". The Hyogo Framework for Action (HFA) regards to motivate the global efforts under the International Framework for Action for the International Decade for Natural Disaster Reduction of 1989, and the Yokohama Strategy for a Safer World: "Guidelines for Natural Disaster Prevention, Preparedness and Mitigation and its Plan of Action", adopted in 1994; and the International Strategy for Disaster Reduction of 1999. The Sendai Framework marked a clear shift from managing the impact of disasters to managing and reducing risks that lead to disasters (Mizutori 2020).

Cheong et al. (2022) highlight the value of AI, especially for better-informed choices proceeding with real-time information, in supporting complex adaptation choices and implementation. To get the maximum benefit from AI to mitigate climate change consequences, more advanced examines are required, including:

- *AI assisted prediction models for climate change mitigation;*
- *Role of machine vision in climate informatics and forecasting;*
- *Recent trends in AI to reduce carbon footprints for a sustainable environment;*
- *AI for earth hazard management;*
- *AI to promote eco-friendly energy production and consumption;*

- *AI assisted expert systems for climate change risk prediction and assessment;*
- *AI assisted big data analytics Synergy of IoT, big data, cloud computing, and AI techniques in climate change prediction and mitigation;*
- *Machine learning for sustainable green future;*
- *AI in reducing the impacts of global warming;*
- *Deep learning for sustainable earth surveillance and earth informatics.*

Further, coping with the disasters requires the will of decision makers to take the right actions supported by AI and other emerging technologies (Maher et al. 2022).

5. Conclusion

Monitoring, and gaining new spatial data, through applying the capabilities of AI for gathering, estimation, risk assessment and prophecy helping and can be the right decision for political makers, business decision creators, educators, and researchers to escape the consequences of climate change and to reach sustainable development in the near future. That is a prominent and perhaps the only way for the safety of our generation.

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