Interreg CENTRAL EUROPE
European Union European Regional Development Fund
CHAIN REACTIONS

CHAIN REACTIONS

THEMATIC BRIEF ENERGY - ENVIRONMENT

BIG DATA – ARTIFICIAL INTELLIGENCE **JUNE 2020**

ABOUT THEMATIC BRIEFS

CHAIN REACTIONS addresses the challenge for industrial regions to increase regional capacity to absorb new knowledge and turn it into competitiveness edge and business value. There is a strong need to help SMEs to overcome capacity shortages for innovation and integration into transnational value chains.

The project aims at empowering regional ecosystems with the knowledge and tools to help businesses overcome those barriers and generate sustained growth through value chain innovation.

During the project lifetime CHAIN REACTIONS will publish about every 6 month five thematic briefs presenting the rationale behind specific innovation deployment within selected business areas.

Following to previous thematic briefs already published and dedicated to Big Data and Artificial Intelligence (AI), this new brief of the CHAIN REACTION project presents the big-data challenge in environmental issues. Out of the many promises of big data, environment sustainability is one of the most important ones to implement and maintain.

Big data - Artificial Intelligence in the environmental sector

Big data and Earth challenges

The increasing population, urbanization and industrialization, which our planet has faced within the last centuries, is now forcing society to consider whether human beings are changing the very conditions essential to life on Earth [1]. Many experts argue that big data and artificial intelligence are going to play a very important role in fighting environmental problems in the years to come. Indeed, many environmental problems, such as damage to the biosphere, local air pollution, the spread of harmful substances in the water, and global climatic changes, cannot be studied by experimentation. Mathematical models and computer simulations are needed to get more insight. Big data approaches are helping scientists get a better understanding of the state of the environmental problem and identify new solutions to help them manage natural resources to slow the progression of the worsening epidemic that is gripping our world.

Earth protection is becoming a growing concern in the years to come. Some experts have said that many environmental problems like climate changes may be irreversible if we are unable to reverse the problems within the next years. This is a good reason to believe that big data could help solve the problem. Figure 1 highlights priorities for six of the world's most pressing environmental challenges and the priority action areas for successfully addressing them.

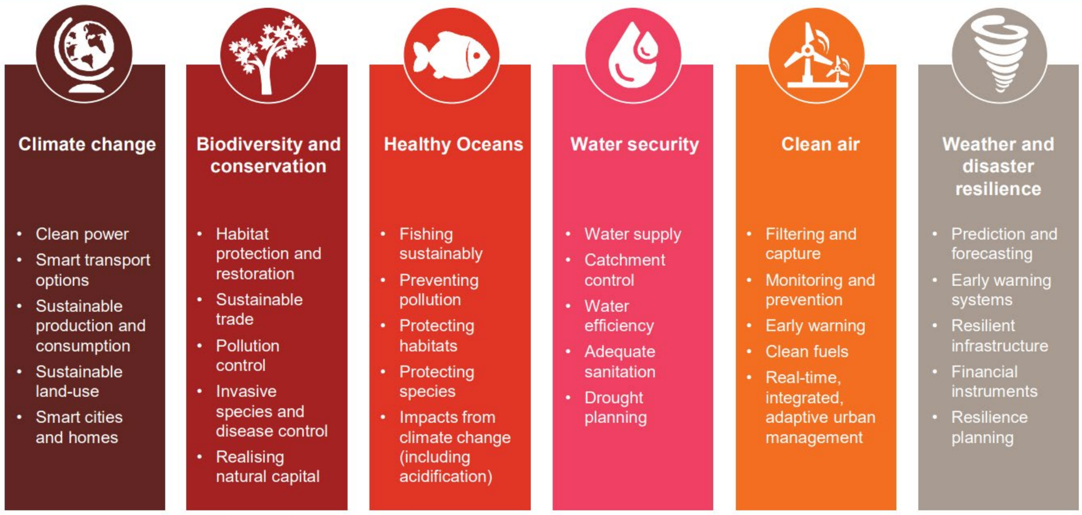

Figure 1 - Priority action areas for addressing Earth challenge areas - PwC research [2]

An effective protection of our environment by tackling all these challenges is indeed largely dependent on the quantity and quality of the available information used to make an appropriate decision. The global proliferation of Earth and environmental datasets now opens new avenues for discovery. But as this available information are huge in quantity, nonuniform (i.e. coming from many different disciplines or sources) and somewhat uneven in quality, performing big data technologies will be needed in conjunction with innovative Artificial Intelligence (AI) approaches.

Finding Better Ways to Manage Resources

From sources such as satellites, sensors, measurements and social media, how can data analytics benefit environmental protection? From deforestation, pollution to water resources management, what problems can scientists and industry address by analyzing these vast data collections? Many industry experts and research scientists are currently working on a big range of projects. From urban planning to monitoring wildlife, they explore the complexities of managing and analysing big data to seek innovative solutions.

From the beginning, Artificial Intelligence has been applied to environmental management problems as, for example, in using expert systems advising emergency response teams about how to deal with industrial accidents, in using expert systems to assist in granting hazardous waste site permits, in modelling water quality, fish stock prediction, and many other environmental engineering applications. Today, many projects around the world using big data and artificial intelligence technologies are trying to improve our knowledge and know-how on managing natural resources worldwide.

The application of big data to curb environmental damages is today what is known as "green data". Many projects in this area are currently running all around the world. For instance „Copernicus" is a European program for satellite-based Earth observation capable of calculating the influence of rising temperatures on river flows. Copernicus is providing key information to optimize water resource management, biodiversity, air quality, fishing and agriculture. "Aqueduct" is an other international projects that use green data to combat climate change. This water-risk mapping tool designed by the World Resources Institute (WRI) is measuring water-related hazards, analyzing water quality and quantity. Aquaduct is relying on big data, such as water quantity, quality and other changing regulatory issues. An other example for well advanced collaborative project is the „Global Forest Change" tool of the University of Maryland that is calculating deforestation by counting trees one by one using high-resolution satellite imagery from Google's Earth Engine.

Rain for Climate's drones

Many companies, startups and SMEs are working to restore ecosystem stability around the world. Rain for Climate, an innovative Slovak startup, is one of them. This team has designed a solution which can help areas which have lost water, or those with unnatural flooding recover, using AI to analyze aerial data gathered by drones. Based on these data, the team can provide bespoke solutions for each individual case. Rain for Climate's solution involves gathering territorial data with drones, which can provide perspective and information faster and more accurately than standard ground-level analysis. This data can then be used to create a personalized report for each customer, based on the needs of their land, providing bespoke technical solutions from a catalog of over 5,000 different possible measures and actions.

Energy management and energy transition

Applying big data to environmental protection is also helping to optimize efficiency in the energy sector. For example, machine learning is being used to match energy generation and demand in real-time, decreasing unpredictability while increasing efficiency, power balancing, use, and storage of renewable energy.

In Norway, Agder Energi [3] is using AI to predict and prepare for changing energy needs, particularly given the rapidly increasing penetration of electric vehicles in this country. DNV GL, an international company also headquartered in Norway, use sensors attached to solar and wind power generation plants to supply data for machine learning monitoring capability, enabling remote inspection of sites, predictive maintenance, and energy resource forecasting [4]. Within buildings, machine learning algorithms are also being deployed to analyze data from millions of sensors to provide predictions on energy usage requirements and cost. JTC of Singapore is deploying such a system to monitor, analyze and optimize energy efficiency in buildings [5]. Machine learning algorithms are also being used at the design phase to model energy efficient building layout further optimizing buildings' efficiency in both the production and, more important, in-use phase [6].

Big data is also already contributing to competitiveness of renewable energies:

- Hydroelectric power: Big data contributes to avoiding leaks in the power plants and to having greater control over water flows.
- Wind power: complex algorithms for wind condition prediction helps determine the amount of energy that is going to be produced.
- Photovoltaic energy: big data helps to optimize the efficiency of power stations by allowing them to adapt to the luminous intensity at any given moment.

Data Hub from Opinum

Opinum is a Belgian company developing the "Opinum Data Hub" platform, designed for energy and environmental actors [7]. Opinum Data Hub covers all stages of the data management value chain to allow its users to look beyond the complexity of data and focus on their core value and expertise. Opinum Data Hub is mainly intended for large private and public service companies, energy suppliers and companies with expertise in energy management (ESCO). This solution is a secured Cloud-based platform that allows energy and environmental actors to centralise, enhance, analyse, and visualize their data. Because Opinum Data Hub is designed specifically for energy and environmental actors, it includes built-in industry-standard rules, capabilities, and analytics, which enable the clients to exploit their data more precisely, quickly, and securely.

Smart cities and E-mobility

The United Nations has projected that two-thirds of the world's population will be living in cities by 2050. This reality poses environmental challenges that AI could help to solve. Many initiatives are using the analysis of big data to create smarter, more sustainable cities. The Trash Track project already installed in 2009 GPS sensors in waste to better understand recycling pathways. MIT researchers were there tracking trash to encourage consumers to recycle by illustrating the amount of energy required to dispose of waste. Another example of innovation is also since several years on cities roads: the Copenhagen Wheel transforms ordinary bicycles quickly into hybrid e-bikes that also function as mobile sensing units. It collects data on air quality, noise levels and road conditions.

For smart transport, machine learning algorithms employing car-sourced information are already widely used to optimize navigation (e.g. Waze [8] and Google Maps). They can also contribute substantially to increase safety, reduction congestion and better manage traffic flows (e.g. Nexar) [9]. At the urban level, these capabilities translate to an ability to integrate public and private modes of transport to create an efficient city mobility service by looking for patterns in transport demand, optimizing routes and improving efficiency and safety [9].

AI guided autonomous vehicles (AVs) - including machine vision algorithms and deep neural net techniques - will enable a transition to mobility on demand over the coming years, and decades. They present opportunities to unlock gas reductions for urban transport. Eco-driving algorithms could prioritize energy efficiency and autonomous ride-sharing services could reduce vehicles miles traveled. Companies such as Tesla are heavily investing in autonomous cars. AI is used to enable the cars to navigate through the traffic and handle complex situations. Testing of these solutions is done with drivers inside the vehicles until the company is able to gain enough data to move towards a completely driverless solution.

The definition of "autonomous" varies depending on the level of automation (see figure). While partially automated cars are in commercial use, the remaining stages combining AI software and IoT sensors (e.g. cameras, radars, lidars) are still under test conditions.

Figure 2 - Levels of Driving Automation [10]

Reverse logistics and Circular Economy

The circular economy is designed to shift our economic model from the extractive and consumptive one currently in place to a system that is restorative and regenerative by design. By keeping materials in biological and technological cycles, the circular economy is reinventing product development and thus requires complex new thinking on network and operational design.

According to a new report (PDF) by the Ellen MacArthur Foundation and Google [11] « AI can help build and improve the reverse logistics infrastructure required to 'close the loop' on products and materials by improving the processes to sort and disassemble products, remanufacture components, and recycle materials. ». In this sense, AI supported by the Internet of Things (IoT) will help to overcome those circular economy challenges.

Indeed, designers working with AI can optimise the design of circular products i.e, create products, components, and materials in line with a circular economy. Iterative machine-learning-assisted design processes can allow for rapid prototyping and testing due to the speed with which algorithms can analyse large amounts of data. AI algorithms can also accelerate the design process by suggesting initial models and adjustments that fit criteria of economy circularity [12].

AI can also support the deployment of circular business models such as product-as-a-service and predictive maintenance (see our thematic brief about AI and manufacturing). It can be used to manage dynamic product pricing or to optimise inventory.

Finally, AI can help to streamline the circulation of materials in the economy: robotic infrastructures can recognize and identify objects for optimal material flow in the economy. AI algorithms can allow for automated assessment of products at the end of their life, using cameras and other sensors, and could make recommendations for whether they can be reused, resold, repaired or recycled.

Conclusion

Within the last years, Big data and AI already demonstrated their capability to contribute to making companies more sustainable by allowing them to optimise energy management and resource use, and to reduce emissions or even to anticipate repair needs. In short, they helps companies to be aware, not only of their direct impacts, but also of those that are produced throughout their entire value chain. Therefore, AI solutions, and their ability to control machines and systems, have caught the public's attention and the benefit of their use to humankind and its environment could be substantial. They could help the society to face the most pressing environmental challenges: climate change, ocean health, water management, air pollution and biodiversity.

However, the use of big data and the growing reliance on algorithms to perform tasks, shape choices and make decisions leads to gradual reduction of human involvement in many processes. Together, this raises issues related to employment, fairness, responsibility, equality and respect for human rights (in particular data privacy).

Government and industry key players will therefore have to ensure the safety, transparency and validity of AI applications. Authorities, AI researchers, technology pioneers and companies using AI solutions must encourage AI deployments that earn trust from the society and guaranty a future that is safe for both people and their planet. This is the condition on which Big data and AI could become one of the biggest industrial success of the 21st century.

Literature

1. A.J. Thomson, "Artificial intelligence and environment alethics," AI Applications, vol. 11, no. 1, pp. 69–73, 1997

2. PwC, Fourth Industrial Revolution for the Earth Harnessing Artificial Intelligence for the Earth, January 2018, available at: https://www.pwc.com/gx/en/sustainability/assets/ai-for-the-earth-jan-2018.pdf.

3. Agder Energi homepage, viewed May 2020, available at: https://www.ae.no/

4. DNV GL, Making Renewables Smarter: The benefits, risks, and future of artificial intelligence in solar and wind, 2017, viewed May 2020, available at: https://www.dnvgl.com/publications/making-renewables-smarter-104362.

5. JTC homepage, viewed May 2020, available at: http://www.jtc.gov.sg/

6. AI. Business, Machine learning and energy efficient building design, March 2017, available at: https://ai.business/2017/03/23/machine-learning-and-energy-efficient-building-design/

7. opinum homapage, iewed May 2020, available at: https://www.opinum.com/

8. Waze, viewed May 2020, available at: https://www.waze.com/

9. Nexar, viewed May 2020, available at: https://www.getnexar.com/

10. SAE International, Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles, June 2018

11. Ellen MacArthur Foundation, Artificial intelligence and the circular economy - AI as a tool to accelerate the transition (2019). http://www.ellenmacarthurfoundation.org/

12. A. Artiach, Artificial Intelligence in the transition to a Circular Economy (2020) - https://medium.com/datadriveninvestor/artificial-intelligence-in-the-transition-to-a-circular-economy-9614bd670a81