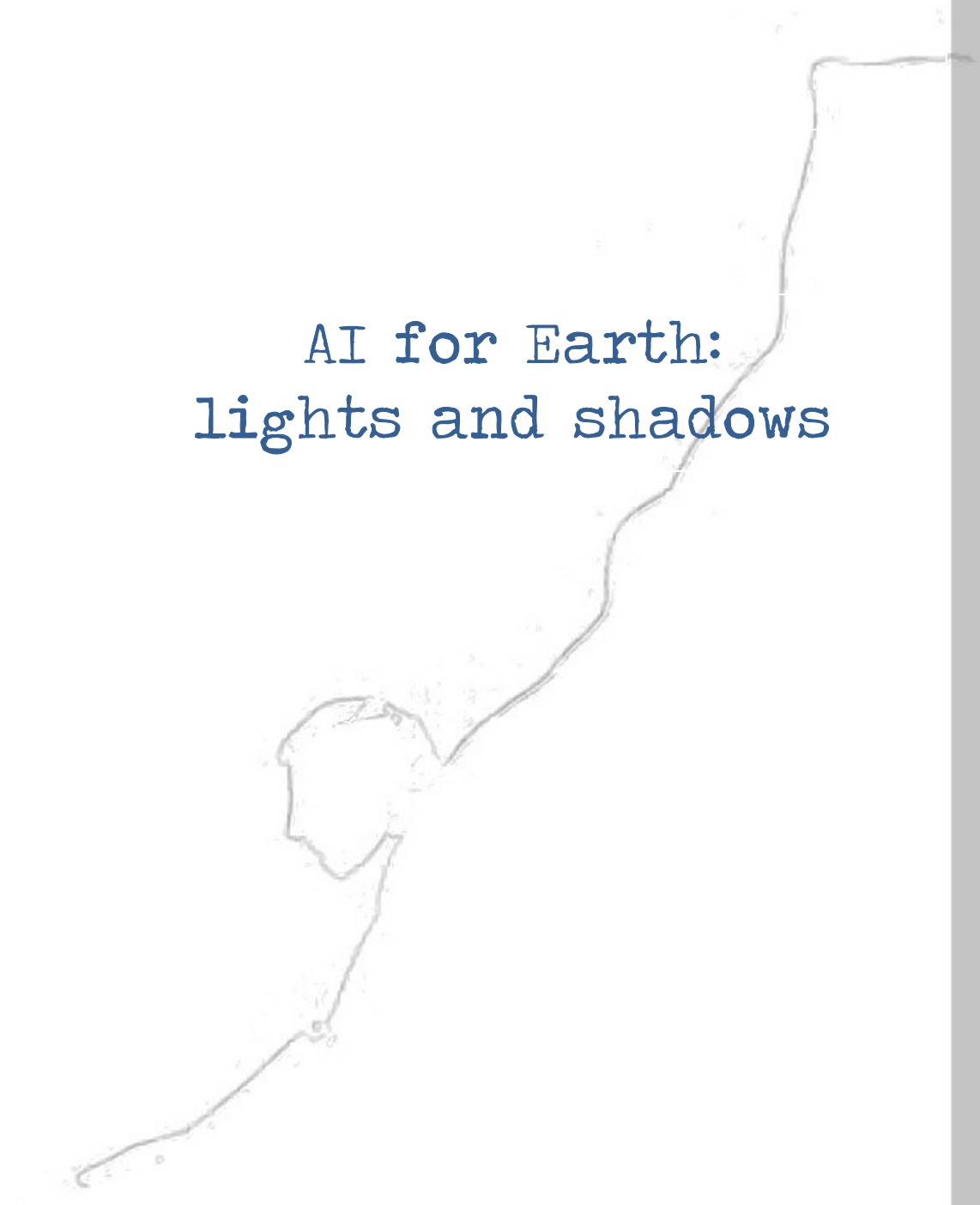
PAPER N. 23
a.a. 2018/2019

Trento BioLaw Selected Student Papers

AI for Earth: lights and shadows



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Co-funded by the Erasmus+ Programme of the European Union

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I paper sono stati selezionati a conclusione del corso *BioLaw: Teaching European Law and Life Sciences (BioTell)* a.a. 2018-2019, organizzato all'interno del Modulo Jean Monnet "BioLaw: Teaching European Law and Life Sciences (BioTell)", coordinato presso l'Università di Trento dai docenti Carlo Casonato e Simone Penasa.

AI for Earth: lights and shadows

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ABSTRACT: The paper outlines the current state of environmental concern at the international level and how environmental law may, in the next years, be influenced by Artificial Intelligence's impacts. In the reasoning, it describes examples of how Artificial Intelligence can be functional to environmental protection, focusing on climate change adaptation and mitigation. Although immediate benefits and advantages will surely derive from this project, the paper also deals with issues and controversies deriving from the use of Artificial Intelligence in an extensive and long term project for the Earth: first of all, AI has the potential to completely change the notion of causation in environmental and climate change litigation and to strengthen the use of the precautionary principle through its predictive functions. Besides this, the right to environmental health has to be balanced with enhanced security and control needs for data subjects and the risk of producing, rather than diminishing, inequalities already present between developing and developed countries.

KEYWORDS: Environmental law; Artificial Intelligence; Climate Change; European law; AI for Earth

1. The international State of Environmental Concern

Times are changing. In 2014, the International Panel on Climate Change published its latest insights into the scope, effects and causes of climate change[1] and it reaffirmed that the Earth has been warming as a result of the high increase of CO2 concentrations in the atmosphere, released since the Industrial Revolution started in 1850[2] and that this has been caused by human activity, particularly the combustion of coal, oil, natural gas as well as deforestation, increasing livestock farming and fertilisers containing nitrogen and fluorinated gases[3]. Climate change is thus the long term consequence of a general environmental destruction perpetrated during 150 years. More concretely, environmental disasters are a daily reality, being them directly related to climate change or just a product or negligent human previsions: some examples are the Brumadinho dam disaster[4] in 2019, when a dam collapsed causing a huge mud slide in

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[1] IPCC, *Contribution of Working Groups I, II and III to the Fifth Assessment Report, Synthesis Report,* Geneva, 2014.

[2] N. J. ABRHAM, H. V. MCGREGOR, J. E. TIERNEY, M. N. EVANS, N. P. MCKAY, D. S. KAUFMAN & THE PAGES 2K CONSORTIUM, *Early onset of industrial-era warming across the oceans and continents,* in *Nature*, volume 536, 2016, 411-418.

[3] https://ec.europa.eu/clima/change/causes_en (last viewed on 22/04/19).

[4] https://www.bbc.com/news/av/world-latin-america-47014595/brazil-dam-collapse-rescuers-search-for-hundreds-buried-under-mud-slide (last viewed on 22/04/19).

Brazil leaving hundreds dead, the record pollution in Mongolia[5], intrinsically connected with climate change and the recent Cyclone Idai flooding Mozambique, Zimbabwe and Malawi[6]. Being the law intrinsically intertwined with the society's development, it must deal with society's urgencies otherwise it might lose its standing. Due to this reason, people turn to the law searching for conscious and immediate action to make a change, a change which is increasingly needed across the globe: in 2013, well before the Paris climate agreement was signed, a median of 56% of citizens in the 23 countries surveyed found global climate change to be a major threat to their country. That climbed to 63% in 2017, and in 2018 it stood at 67%[7].

The fundamental problem when dealing with global problems as climate change, however, is that the classical juridical concepts are unfit to describe the enormous transformations we are living in. Nevertheless, is also true that standing aside in the long term project which is adaptation and mitigation to climate change will surely be considered as a fault by those who will bear the consequences of our actions. The difficulties we are facing are partially related to the fact that legal history evolved within gradualism and rationalism, leaving catastrophism to science fiction and with that avoiding public concern and the uncomfortable question of what was to be done, of what shall we do now that entire communities have to be transferred, now that real measures will have to be taken, now that the issue is no science fiction anymore. Litigation is trying to answer those questions, as we shall see later in this discussion. However, the role of law in these crucial years is to answer this question not only on a case by case level but to engage in a profound discussion with civil society, too: the task is to recognise the environment as a priority, as an element having its own identity, which is not simply a reflection of our impact on it. As stated by the European Environmental Agency, «we live in a continuously changing context in which [...] we must ensure that the environment can be used to meet material needs and at the same provide a healthy living space and it is clear that tomorrow's economic performance will depend on making environmental concerns a fundamental part of our economic and social policies, rather than merely regarding nature protection as an add-on»[8].

The right to live in a healthy environment surely entails questions of non discrimination, social equality and is clearly linked to the right to health but we should forget these considerations for a moment to leave space to the environment *per se,* as having the right to exist, disconnected from the faith of humanity and therefore recognise it as it is: a brutal force in which we are submersed that must be taken into account, not a rational and calm reflection of our own image. Amitav Ghosh, Indian writer, while recalling the disaster happened on the shores of the Padma River during the 1850s which made the river change course

[5] https://www.nationalgeographic.com/environment/2019/03/mongolia-air-pollution/ (last viewed on 22/04/19).
[6] OCHA, *Mozambique: Cyclone Idai & Floods Situation Report No. 13*,14 April 2019.
[7] Pew Research Center, *Spring 2018 Global Attitudes Survey.*
[8] https://www.eea.europa.eu/soer-2015/synthesis/report/1-changingcontext (last viewed on 22/04/19).

and drown the nearby village of his ancestors, wrote: «[t]his is what I imagined my forebears experienced that day when the river rose up to claim their village: they awoke to the recognition of a presence that had molded their lives to the point where they had come to take it as much for granted as the air they breathed»[9]. If we really look into that presence, that environmental externality we often refuse to take into account until it eventually damages us, recognition is difficult because it entails a disproportionate number of variables, of unexpected visions, by which the rational approach of rigid law is swiped away. Nevertheless a great opportunity, and with that a great challenge, coincides with our times of uncertainty: do AI-powered technologies have the possibility of changing the way practitioners and scholars of law perceive the complexity of the environmental connections?

2. Artificial Intelligence: a brief overview

Since the 1950s, Artificial Intelligence has evolved from its roots in programs that merely executed instructions specified by the programmer into machine-learning algorithms that can learn, adapt to changes in a problem's environment, establish patterns in situations where rules are not known and deal with incomplete information[10]. The emergence of Artificial Intelligence as a full-fledged field of research coincided with three important meetings: in 1955 a «Session on Learning Machines» was held in conjunction with the 1955 Western Joint Computer Conference in Los Angeles, in 1956 a «Summer Research Project on Artificial Intelligence» was convened at Dartmouth College and in 1958 a symposium on the «Mechanisation of Thought Processes» was sponsored by the National Physical Laboratory in the United Kingdom.[11] The work has continued since then: AI gradually became a collection of computational components to build systems that emulate functions carried out by the human brain[12]and an intelligent system expected to work, and work well, in many different environments, which property of intelligence allows it to maximise the probability of success even if full knowledge of the situation is not available[13].

One of the traditional classifications of the field consists in the division between Knowledge Based AI, needing human intelligence to function and Data Driven AI, which instead relies on human data in its operations[14]. This distinction has particular implications if we analyse the Artificial Intelligence's or so called Machine Intelligence's multiple branches: Machine Learning, which comprehends Deep Learning and can be supervised or unsupervised, Natural Learning Processing (NLP) with context extraction, classification, machine translation, question answering and text generation. Functions may go on with applications in

[9] A. GHOSH, *The great derangement*, 2016.
[10] Y.BATHAEE, *The Artificial Intelligence black box and the failure of intent and causation*, in *Harvard Journal of Law & Technology*, 31, 2, 2018.
[11] N.J. NILSSON, *The quest for Artificial Intelligence*, 2009.
[12] L. STEELS, R. LOPEZ DE MANTARAZ, *The Barcelona declaration for the proper development and usage of artificial intelligence in Europe*, Barcelona, 2018, 488.
[13] S. LEGG, M. HUTTER, *A collection of definitions of Intelligence*, 2007.
[14] L. STEELS, R. LOPEZ DE MANTARAZ, *The Barcelona declaration for the proper development and usage of artificial intelligence in Europe*, cit., 487.

Vision, meaning image recognition and machine vision, applications in Planning, applications in Speech (text to speech and speech to text) and finally, Robotics. The range of AI applications is so broad that it will swipe away our common understanding of the world and in practice it is already doing so. Affected sectors are without any doubt the high techs and communications, the automotive and assembly, financial services, resources and utilities, media and entertainment, consumer packaged goods, transportation and logistics, retail, education, professional services, health care, building and construction, travel and tourism[15].

3. Environmental purpose of Artificial Intelligence and UN Sustainable Development Goals

Even if we are all more or less familiar with the AI scopes mentioned above, there is an often unmentioned use of this technology: it could help in the process of climate change adaptation and mitigation.

As stated by the Executive Office of President Obama in 2016, «[o]ne area of great optimism about AI and machine learning is their potential to improve people's lives by helping to solve some of the world's greatest challenges and inefficiencies. Many have compared the promise of AI to the transformative impacts of advancements in mobile computing. Public and private sector investments on AI have already begun reaping major benefits to the public in fields as diverse as health care, transportation, the environment, criminal justice, and economic inclusion»[16].

But what does the problem itself consist of? Scientists have identified nine processes and systems that regulate stability and resilience of Planet Earth and four of these nine have now crossed boundary levels due to human activity: the Earth is facing climate change, loss of biosphere integrity, land-system change and altered cycles in its chemistry[17].

If those processes are impaired in their functions, there is surely no room for achieving any of the Sustainable Development Goals (SDGs) such as good health and well being, clean water and sanitation and the aspiration to zero poverty around the world, unless action is immediately taken. This action, as stated in the Research Paper of the World Economic Forum System Initiative on Shaping the Future of Environment and Natural Resource Security titled «Harnessing Artificial Intelligence for the Earth », could include Artificial Intelligence as an instrument to create maximum positive impact on urgent environmental challenges[18].

Taking into account the SDGs, there are six challenges facing humanity in an environmental perspective: combating climate change, using ocean and marine resources wisely, managing forests, combating

[15] https://blogs-images.forbes.com/louiscolumbus/files/2017/07/AI-Adoption.jpg.
[16] Executive Office of The U.S. President, *Preparing for the future of artificial intelligence*, Washington D.C, 2016.
[17] World Economic Forum, *Harnessing Artificial Intelligence for the Earth,* 2018, 5.
[18] World Economic Forum, *Harnessing Artificial Intelligence for the Earth*, 2018.

desertification, reversing land degradation, developing sustainable cities and providing clean affordable energy[19].

A disclaimer is nevertheless necessary: AI could be of enormous help in reaching those goals but it could also be used in such ways to impair the general basis of consensus that those goals have, for example, through fake news or by the use of algorithms commonly found in social networks, which enhance social polarisation by targeting users with content selected upon their preferences, making it easier for a small minority to control the boundaries of common knowledge. Eli Pariser coined the term filter bubble to describe the potential for online personalisation to effectively isolate people from a diversity of viewpoints or content. Online recommender systems are built on algorithms that attempt to predict which items users will most enjoy: they are built for collecting knowledge at a faster pace than any instrument we had before[20]. If knowledge and thus the modern data are power, then asymmetries in knowledge may translate in asymmetries in power[21]: the classical national sovereign state is confronted with a loss of centrality, compared to tech giants which are instead increasing their influence on every sphere of life. That is, partially, why it is increasingly difficult for national hard law to tackle problems that require broad popular consensus such as climate change. A consideration dealing with the problem is found in the Barcelona Declaration for the proper development and usage of Artificial Intelligence in Europe: «[...] these AI algorithms are now held (at least partly) responsible for allowing the emergence of a post-truth world, highjacking democratic decision processes, and dangerously polarising society. Polarisation is making it much more difficult to deal with the big issues facing our society, such as climate change mitigation, diminishing pollution, achieving economic prosperity for an exploding world population, avoiding violent conflicts due to ethnic, nationalistic or religion diversity, coping with massive migration, etc. They all require determined collective action and therefore a political consensus. AI should (and could) help to support consensus formation rather than destroy it»[22].

[19] United Nations Sustainable Development Goals, available at: http://www.un.org/sustainabledevelopment/sustainable-development-goals/. The goals include: 1. End poverty; 2. End hunger; 3. Ensure health and well-being; 4. Quality education; 5. Gender equality; 6. Clean water and sanitation; 7. Affordable and clean energy; 8. Decent work and economic growth; 9. Resilient infrastructure, industry and innovation; 10. Reduce inequalities; 11. Sustainable cities and communities; 12. Responsible consumption and production; 13. Climate action; 14. Life below water; 15. Life on land; 16. Peace, justice and strong institutions; and 17. Revitalise global partnerships for the goals.

[20] T.T. Nguyen, F. M. Harper, L.T. Joseph, A. Konstan, P. Hui, *Exploring the Filter Bubble: the Effect of Using Recommender Systems on Content Diversity*, in WWW 2014 - *Proceedings of the 23rd International Conference on World Wide Web*, 677-686.

[21] E. Pariser, *The Filter Bubble: What the Internet is Hiding from You*, New York, 2011.

[22] L. Steels, R. Lopez De Mantaraz, *The Barcelona declaration for the proper development and usage of artificial intelligence in Europe*, cit., 486.

4. The European standing in enhancing technology and AI for the environment

Although it is arguable whether the EU can be considered an environmental protection leader worldwide[23], it has been one of the few entities at the international level constantly taking challenging actions to merge policy making with sustainability and a long term project to decarbonise the European economy. For this reason, it may be particularly interesting to analyse the European standing when it comes to matching technology and environmental law.

The development of EU environmental law has as its main provision Article 4 of the Treaty on the Functioning of the European Union, classifying the environment as a shared competence under the Lisbon Treaty[24]. A high level of environmental protection and the improvement of the quality of the environment must be integrated into the policies of the Union and ensured in concurrence with the principle of sustainable development, according to Article 37 of the Charter of Fundamental Rights of the Union[25]. Article 191 of the TFEU is a milestone in this sense, too: it calls on member states to preserve, protect and improve the prudent utilisation of natural resources, to embrace the precautionary principle and the polluter pays principle, entailing the obligation to take into account available scientific and technologic data.[26] These three articles are of enormous importance in providing a subset for scientific data on the state of environmental degradation to be taken into account in policy making and therefore in allowing the application of the latest technologies such as AI in the environmental field.

Communication 2018/673, titled «A sustainable bio economy for Europe» is specifically connected with the achieving of Sustainable Development Goals and describes the next years' developments as the «merging of digital, psychical and biological worlds» and lies down the goal of promoting AI not only in its applications but also in enhancing knowledge base and understanding of how AI systems work[27]. In the same Communication we find the EU's commitment to «intensify the mobilisation of public and private stakeholders, in research, demonstration and deployment of bio-based solutions. This includes, for example, the promotion of technologies such as artificial intelligence and innovative solutions that are suitable for small scale deployment and easy to replicate». AI is thus presented as a game changing solution for small businesses which engage with biological resources and therefore with environmental matters. Moreover, in the previous European Parliament Resolution of February 2017 on Civil Rules on Robotics, there is a substantial agreement under the title «Environmental impact» to have robotics and AI

[23] C. F. PARKER, C. KARLSSON, M. HJERPE, *Assessing the European Union's global climate change leadership: from Copenhagen to the Paris Agreement*, in *Journal of European Integration*, 39, 2, 2017, 239-252.
[24] The Lisbon Treaty, 2007, Article 4 of the Treaty on the Functioning of the European Union.
[25] The Charter of Fundamental Rights of the European Union (CFR), 2007, in *Official Journal of the European Union.*
[26] The Lisbon Treaty, 2007, Article 191 paragraphs 1,2,3, Treaty on the Functioning of the European Union.
[27] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, *A sustainable Bio-economy for Europe: Strengthening the connection between economy, society and the environment*, 11th of October 2018.

development realised in such a manner that the environmental impact is limited through effective energy consumption, by increasing energy efficiency with the use of renewables and producing minimum waste. The Parliament also encourages the Commission to incorporate the principles of a circular economy into any Union policy on robotics and notes that the use of robotics will surely have a positive impact on the environment, especially in the fields of agriculture, food supply and transport, notably through the reduced size of machinery and the reduced use of fertilisers, energy and water, as well as through precision farming and route optimisation[28].

These commitments are enormously important because of the necessity to create carbon free products in robotics and to ensure that regulation takes into account the use of clean energy sources: in issuing a permit for a new AI project the environmental impact must be assessed and minimised. To make an example of how this type of ideas operate in practice, Google's Deep Mind AI, the British Artificial Intelligence company, is following the goal of being powered 100 percent by renewable energy. The project in 2016 got around 3.5 times the computing power out of the same amount of energy it used at the beginning of the research and by applying Deep Mind's machine learning to Google data centres, it has managed to reduce the amount of energy used for cooling by up to 40 percent[29]. In this respect, one of the most worrying models predicts that electricity use by ICTs in general could exceed 20% of the global total by the time a child born today reaches her teens, with data centres using more than one-third of that[30]. Regulation must therefore look at possibilities such as Deep Mind's project to avoid that technology develops careless of creating a vicious circle of energy consumption.

Coming back to the European Union, it is thus clear that on one hand it embraces environmental protection and innovation functional to this protection, while on the other hand it has recently proposed some ethical guidelines for a human-centric AI, putting limits to this innovation even if not yet in legislative terms. In the latest version of those guidelines, the EU also affirms AI should be used to enhance sustainable development, giving a clear direction for the years to come[31]. We might get a sense of what an European future could look like by looking at the Data Bio Project, which is financed by the EU Horizon 2020 and is at the basis for a more responsible use of data in agriculture, forestry and fisheries. To understand implications of these types of technologies we need first thing to know how they work: Data Bio works through structured and unstructured data, spatial temporal data, machine generated data, image, sensor data, geospatial data and genomics data.[32] We will have a glimpse of what consequences flow from the use of these different sources of data in the next paragraph.

[28] European Parliament Resolution, *Recommendations to the Commission on Civil Law Rules on Robotics*, 16th of February 2017.
[29] https://deepmind.com/blog/deepmind-ai-reduces-google-data-centre-cooling-bill-40/ (last viewed on 22/04/19).
[30] A. ANDRAE, T. EDLER, *Challenges*, 2015, 117-157.
[31] http://europa.eu/rapid/press-release_IP-19-1893_en.htm (last viewed on 22/04/19).
[32] https://www.databio.eu/wp-content/uploads/2017/05/FactSheet.pdf (last viewed on 21/04/19).

5. Examples of AI applications to contemporary environmental issues

Information technologies play an increasing and central role in the planning, prevision, supervision and control of environmental processes due to different actors of civil society which have started calling for the explicit consideration of environmental impact in planning and decision-making process of large projects.

With the rising of environmental informatics, Artificial Intelligence techniques started to be applied to environmental problems in three different ways: data interpretation and data mining to detect patterns and identify connections between past and current situations, problem diagnosis techniques to develop hypothesis about possible causes, strategies to recover and finally decision support techniques to evaluate alternatives and compare costs and benefits[33]. These three different functions have numerous applications: all of them can be considered AI game changers for the Earth.

If we made up a time line taking off from today, the first innovations coming up in the Fourth Industrial Revolution that could heavily influence the environment are autonomous and connected electric vehicles (EVs), which promise to reduce gas emissions and encourage car sharing[34]. Connected cars would then take their energy from distributed grids (applications of machine learning and deep learning, using the Internet of Things and blockchain mechanisms), which are of fundamental importance: they can enhance the predictability of demand and supply for renewables or allow a solar road to heat up to melt snow or adjust traffic lanes based on vehicle flow. Smart or precision agriculture is revolutionary in the same way: based on data collection and decision making it can increase resource efficiency lowering the use of pesticides, and that is just an example. In this type of scenario AI will be used together with robot labor, drones, synthetic biology and sensors.

AI also has the capacity of improving weather forecasting and climate modelling: public agencies including the UK Met Office and NASA and private sector actors such as IBM and Microsoft are already experimenting those types of technologies[35]. Other possible applications include: building a community disaster response data and analytics platform to enhance resilience to climate change, having a system of decentralised water optimising demand and supply or an oceans data platform such as the Ocean Data Alliance[36], which if fully developed could allow decision makers to use machine learning to monitor, predict and respond to illegal fishing and disease outbreaks.

AI designed intelligent, connected and liveable cities will be a fundamental change in the way city planners look at disaster preparedness (through Augmented Reality and Virtual Reality techniques) with minimum pollution and increased energy efficiency. An idea for conservation and natural resources recently

[33] U. CORTES, M. SANCHEZ-MARRÈ, L. CECCARONI, *Artificial Intelligence and Environmental Decision Support Systems*, in *Applied Intelligence* 13, 2000, 77-91.

[34] All of the examples are featured in the World Economic Forum, *Harnessing Artificial Intelligence for the Earth*, 2018.

[35] E. JONES, *How Machine Learning could help to improve climate forecasts*, in *Nature*, 548, 379–380.

[36] WEF, *Pledge to stop illegal tuna fishing and related forced labour on the high seas by 2020*, New York, 2017.

becoming reality is the Amazon Third Way Initiative, which is developing the Earth Bank of Codes (ECB): an open, global and public good digital platform that registers nature's assets helping implementation of the Nagoya Protocol of the Convention on Biological Diversity.[37] The technology to enact those projects is already there, what is lacking are large amounts of data to let AI function at its fullest level and realise a sort of «real time digital dashboard of the Earth», which could have profound implications for natural resource management including policy making and dispute settlement.

6. Critical issues related to an extensive and long term employment of AI and Robotics in environmental law

Artificial Intelligence may thus be the most powerful tool we ever had against climate change and environmental fatalities but its use also entails taking a bold risk when it comes to dealing with such delicate matters as environmental protection. The right to environmental health is in itself an unsolved matter. Some authors perceive environmental protection as a human right that has the possibility to descend from already existing rights at the international level: civil and political rights, economic social and cultural rights and the right to self determination[38]. Nevertheless, only a few national constitutions contain the right to the environment: the Spanish Constitution in article 45 (1), the Republic of South Africa's Constitution (section 24) are some examples. The sole presence of these provisions is not a guarantee of applicability and indeed the human right to the environment is still conceived as primarily a procedural right[39] and not a substantive one, at least in most of the cases. According to this reasoning and even if we considered there to be a procedural right only, meaning a right to information, participation and justice in environmental matters, the right still clashed with some aspects of Artificial Intelligence which must be taken into account in a serious analysis of checks and balances.

6.1. Artificial Intelligence's analysis functions in environmental and climate change litigation

It is so challenging to imagine and truly understand the whole range of possibilities and applications when it comes to AI that it would be interesting to ask ourselves whether we are ready for that revolution, for that increased form of connectedness realised through IoT, AI and Robotics. The Fourth Industrial Revolution is moving forward at increased speed if compared with the previous ones[40]: the risk is that the law loses sight of technological developments.

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[37] https://www.earthbankofcodes.org (last viewed 22/04/19).

[38] M.R. ANDERSON, *Human Rights Approaches to Environmental Protection* in *Human Rights Approaches to Environmental Protection* (edited by M.R. Anderson, A.E. Boyle), Clarendon Press, 1996.

[39] An example is the Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters. See https://www.unece.org/env/pp/introduction.html (last viewed 22/04/19).

[40] M. XU, J.M. DAVID, S. H. KIM, *The Fourth Industrial Revolution: Opportunities and Challenges*, in *International Journal of Financial Research*, 9, 2; 2018.

In his article «Coevolution of Law and Science» Robert W. Adler addresses the various models of interaction between scientific developments and the law and finds that there are two main schemes to which we may refer: or scientific information alerts society to a problem and forces a regulatory response or the law must catch up with science and therefore impose regulation on scientific innovation[41]. The latter case, according to the author, is the situation experienced with AI tentatives of regulation. But what if AI could be both? What if AI could be used as a subset alerting society and not only forcing a regulatory response but also providing for legal proof in climate change related litigation, acting therefore as an enhancement for legal science itself?

Researchers from the University of Johannesburg, South Africa, and National Institute of Technology Rourkela, India, developed the first robust model for general causality that identifies multiple causal connections without time-sequence data, the Multivariate Additive Noise Model (MANM). It can identify multiple, hierarchical causal factors and works even if data with time sequencing is not available. The model, in the words of its designers, creates significant opportunities to analyse complex phenomena in areas such as economics, disease outbreaks, climate change and conservation[42]. Projects such as this may flower in the next years, leading to a fundamental twist in the process of identifying causation of events which may be climate change related, an unsolved litigation issue[43]. Indeed, even if the effects of climate change are in plain sight, responsibility, if there is one, is difficult to attribute. As Jacqueline Peel, Professor at the University of Melbourne, has said: «climate change is the paradigmatic global environmental problem. Anthropogenic emissions of carbon dioxide and the other GHGs that give rise to atmospheric warming are produced in all countries by innumerable entities. In this sense no one country or entity can be said to be the cause of climate change [...] climate change is thus a "multi scalar" regulatory problem capable of simultaneously engaging more than one level of governance (local, state, national, regional, international)».[44] That precisely mirrors what is happening at the moment: increasing litigations all over the world are trying to challenge the local, regional, national and international efforts to deal with disaster resilience, climate change mitigation efforts, preservation of natural resources[45] and climate change refugees[46]. The roots for this challenging may be national constitutions[47], statutory law[48], international

[41] R.W. ADLER, *Coevolution of Law and Science: A Clean Water Act Case Study*, in *Columbia Journal of Environmental Law*, 44, 2019.
[42] P.K. PARIDA, T. MARWALA, S. CHAKRAVERTY, *A multivariate additive noise model for complete causal discovery*, in *Neural Networks*, July 2018.
[43] UNEP, Columbia University, Sabin Center for Climate Change Law, *The status of climate litigation: a global review,* May 2017.
[44] J. PEEL, *Issues in Climate Change Litigation*, in *Carbon & Climate Law Review*, 2011, 16
[45] See *Alberto Castilla et al v. Colombia*, Colombia's Constitutional Court.
[46] See *Ioane Teitiota v. The Chief Executive of the Ministry of Business, Innovation and Employment*, New Zealand.
[47] See *Urgenda Foundation v. The State of the Netherlands*, Hague District Court and *Greenpeace Nordic Association and Nature and Youth v. Ministry of Petroleum and Energy*, Oslo District Court.
[48] See *Thomson v. Minister for Climate Change Issues*, High Court of New Zealand.

law[49], on the basis of the right to healthy and clean environment[50] or the common law tort of negligence[51]. According to the UN Report on the Status of Climate Change Litigation[52], from the problem of causation stem other issues surrounding this type of litigation: justiciability in the first place of climate change damages, standing of cases with these premises before the courts and separation and balance of powers related to the courts deciding on a question implying a policy choice. A critical issue is represented by the fact that justices may well be masters of climate change science or of Artificial Intelligence but they are currently not required to. In the words of the European Judicial Training Network when issuing a report on Big Data Analytics: «Even if individual judges were trained to understand the results of such models, they will never have the resources to evaluate their accuracy. There may be a need to have some sort of supervision to regulate how private companies produce and publish the results of their models. The results may have a direct impact on law enforcement»[53].

The problem of causation remains unsolved while the Black Box problem's phantom is lingering in the shadow: how will we be able to meet transparency when AI that relies on machine-learning algorithms, such as deep neural networks, can be as difficult to understand as the human brain?[54] Is it possible to reconcile the procedural right to information, participation and justice in environmental matters with the uncertainties of a fundamentally unregulated approach to AI entails? Such questions lead to the next critical issue: AI can be used to define causation much more clearly when arriving to a decision in case law but it can also be applied in its predictive functions to define emergency responses to extreme climate events or to describe a long term policy in terms of adaptation and mitigation of climate change.

6.2. AI's Predictive Functions and The Precautionary Principle implications

Precaution as a fundamental concept often comes up in the environmental discussion as well as in the AI discussion. One of the first occasions when the principle was discussed in environmental law was the Rio Declaration on Environment and Development in 1992, consisting in 27 principles that over 170 countries agreed to take into consideration when making future decisions and policies in the field[55]. Being a declaration it has no binding force but it constitutes a starting point in defining the concept of precaution: in order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent

[49] See *Gbemre v. Shell Petroleum Development Company of Nigeria Ltd,* Federal Court of Nigeria.
[50] See *Re Court on its own motion v. State of Himachal Pradesh and others*, National Green Tribunal.
[51]See *Ralph Lauren 57 v. Byron Shire Council*, Supreme Court of New South Wales.
[52] Unep, Columbia University, Sabin Center for Climate Change Law, *The status of climate litigation: a global review*, May 2017.
[53] http://www.ejtn.eu/Documents/Team%20FR%20semi%20final%20D.pdf (last viewed on 22/04/19).
[54] D. CASTELVECCHI, *Can We Open The Black Box of AI?,* in *Nature,* 538, October 2016, 20-23.
[55]*The Rio Declaration on Environment and Development of 1992*, principle 15.

environmental degradation. Precaution is defined in the Oxford Handbook of International Environmental Law as a strategy for addressing risk: it necessitates the capacity to identify hazards and opportunities, to forecast scenarios and to take anticipatory measures to manage causes before adverse outcomes occur. These complex considerations mean more than an earnest commitment to protecting health, safety and the environment[56]. Taking precaution does not mean, however, that the aim of this precaution is a zero risk situation even if, for example, the UN General Assembly in the World Charter For Nature leans towards «banning activities posing any uncertain risk where potential adverse effects are not fully understood»[57].

Shifting our focus back to Artificial Intelligence, given the Black Box Problem, it can be considered a technology requiring precaution since it may pose a global catastrophic and existential risk in the future, precisely because anticipating and controlling the outcome of highly intelligent AI is difficult, especially if AI is «self-improving» and thus able to alter its own programming[58]. But if this "self improving" aspect is potentially a threat, it also permits AI to enhance its algorithms: inspired by the capacities of the human brain, AI devices integrate the specific attributes of various disciplines, such as mathematics, statistics, physics, computer science, and just recently, environmental engineering applications. Their prediction models have a significant potential for solving complex environmental applications that include large amounts of independent parameters and nonlinear relationships and most of them were implemented for the solution of water/wastewater (55.7%) and air pollution (30.8%) related environmental problems[59]. Thus if on one hand Artificial Intelligence has to be regulated in a precautionary sense due to its high transformational potential, on the other hand the notion of precaution can be strengthened by AI predictions in environmental impacts: in brief, we could finally understand more clearly when precaution is required not to harm the environment and when it is instead necessary to act. The examples of AI applications to environmental issues such as weather forecasting and energy efficiency predictions, spelled out in paragraph 5, could have enormous policy implications, both in the long term and in the short term. The merging of Artificial Intelligence and environmental law could thus be a gold mine to minimise action when possible and reducing inequalities, since in developing countries, which are by the way the most affected by climate change[60], the cost of highly precautionary policies may loom much larger than they do in wealthier countries[61].

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[56] *The Oxford Handbook on International Environmental Law*, New York, 2007, 598-599.
[57] UN General Assembly, UNGA Resolution 37/7: World Charter for Nature, 1982.
[58] G. WILSON, *Minimizing global catastrophic and existential risks from emerging technologies through international law*, in *Virginia Environmental Law* Journal, 31, 2013.
[59] K. YETILMEZSOY, B. OZKAYA, M. CAKMAKCI, *Artificial Intelligence - based prediction models for environmental engineering,* in *Neural Network World,* 2011.
[60] According to Germanwatch and Munich Re NatCatSERVICE, countries most affected by extreme weather events (1997–2016) are: Honduras, Haiti, Myanmar, Nicaragua, the Philippines, Bangladesh, Pakistan, Vietnam, Thailand and the Dominican Republic.
[61] *Oxford Handbook of International Environmental Law*, New York, 2007, 611.

6.3. Security and control risks in a future AI administered city

If any of the existent predictions are accurate then, what will a smart city look like in 2050?

According to a PwC study, we might expect major innovations to be reached by 2030[62]. It will probably be possible to have a real time and public digital dashboard for the Earth, deep reinforcement learning for new superconductor discoveries: this would entail a democratisation of the process of scientific progress due to the fact that average home computers will practically be the equivalent of a today's supercomputers. AI designed cities however, will probably be one of the first mainstream innovations related to the Fourth Industrial Revolution we will be experiencing: cities will be transformed through deep learning leading to better resilient, human centric agglomerates with minimal air pollution and environmental impact. AI could be also used to automate the generation of zoning laws, building ordinances and floodplains. For example, IBM is currently working on a project called Green Horizons which leverages cognitive computing and the Internet of Things (IoT) to enable city governments, utility companies, and the industries to improve their relationship with the environment and in particular air quality management[63].

What this means in practice is that thousands of sensors are displayed across physical and man-made environments: in this way the Internet of Things generates vast amounts of real-time data which then is filtered through cognitive computing that learns from experiences and connects the dots to generate predictive models showing where pollution is coming from, where it will likely go, and what will be its potential effect. Although, as we've seen in the previous paragraph, these types of projects are enormously beneficial because they enable to understand how complex environmental variables relation one with another, they do so in a way that may be considered disruptive of privacy guarantees. Having sensors deployed in such an extensive way means that every moment of a human's life will be regulated, predicted and his interaction with AI will be registered and used by AI to improve its performance.

The use of wearable technology is one of the main issues related to data collection through sensors. More and more people are concerned about their environmental health and they are right to do so: according to a report issued by the International Energy Agency in 2016, each year about 6.5 million deaths worldwide are linked to air pollution, which is likely to increase unless we make a sustained effort to reduce global emissions[64]. Data from the broadly employed stationary air-monitors will still be useful, but leveraging wearable technology promises to collect data on pollution exposure at an individual level. The main problem is that commercially available wearables are made by private entities touting their products for the public good and users often assent to providing data to companies when operating their products; however, there are times where participants do not realise that they are providing data to a company that might monetise their data by selling it to a third-party or charging users a fee to access their own data in

[62] World Economic Forum, *Harnessing Artificial Intelligence for the Earth,* 2018.
[63] https://www.research.ibm.com/green-horizons/interactive/ (last viewed on 22/04/19).
[64] https://www.iea.org/publications (last viewed on 22/04/19).

the future[65]. While there is no doubt that private entities can have a genuine interest in protecting the environment, the user must not be put in the situation of choosing between some knowledge on his or her environmental health and privacy regarding all sort of personal data. If this type of balance of rights is not sorted out it is not unlikely that a third-party could steal and make user data available to health insurance companies, which could result in higher premiums for individuals living on or near polluted sites. Even if these technologies are being developed for the public good, developers need to remain critical regarding their potential to harm. The risk is that regulators trust the idea of AI for good without taking into consideration its risks because considered too remote and this same good becomes just a shield for other economic interests: the same capitalistic interests which led the Earth to its current state of degradation. It is important in this sense for regulation to take a necessary step and ensure that centralisation of data does not occur to the extent it would lead to an increased risk of cybercrime. To make an example, hackers could access automated warning systems of the municipality, distributed grids or connected autonomous transport platforms and cause regional disruptions. Misuse of AI could also occur when systems fall into the wrong hands: for example, poachers could profit from AI enabled endangered animal tracking tools meant for conservation efforts. The usual defence and prevention against cyber crime is cryptography, which is currently a powerful instrument, permitting to protect the private communication of individuals and organisations. Cryptography protects our information as it travels over and is stored on the internet, whether we are making a purchase from an online store or accessing work email remotely.

Unfortunately current cryptography will become useless when quantum computers will be available on the market, which could happen really soon: there is now a consensus among some of the biggest players in technology, including Google, Amazon and Microsoft, that quantum computers will be a commercial reality by 2026[66]. Existing public-key cryptography is based on the difficulty of factoring and the difficulty of calculating elliptic curve discrete logarithms and those two problems will be readily and efficiently solved by a sufficiently large-scale quantum computer. Microsoft, to give just one example, is for this reason looking at cryptography approaches that appear to be resistant to an attacker who has access to a quantum computer[67].

This is not the only solution: some may even revert to low-tech, taking sensitive information offline and relying on in person exchanges. But historical data will be vulnerable too: if someone steals conventionally encrypted data now, he can bide time until quantum advances helps to access it, regardless of any stronger precautions you subsequently put in place[68]. If defining and putting boundaries on AI is hard, quantum

[65] http://www.kbs.msu.edu/2017/07/wearable-tech-sackey/ (last viewed on 22/04/19).
[66] F.WERNER, *Quantum computing: New threats require new security approaches*, in *ITU News Magazine*, 2017.
[67] https://www.microsoft.com/en-us/research/project/post-quantum-cryptography/ (last viewed on 22/04/19).
[68] WEF, *The Global Risks Report*, 2019, page 67.

computing could result in the worst nightmare ever for regulators all over the world. But, as always, the complexity of connections that could lead to misuse of quantum computing is the same complexity that would permit us to finally understand the way nature operates: classical computers cannot compute things the way nature does; they are limited to the human made binary code (of zeros and ones) rather than the natural reality of continuous variables. In other words, with classical computers we are currently modelling the Earth system in a way that it does not actually function. Quantum computers open the door to solving the quantum problems as they exist in nature.

It is clear from this very general picture that we will surely need to approach the concept of consent in a completely different way: how is it possible to control our personal flow of data when sensors may register all sort of informations and quantum computing may open up public data reservoirs? The current source of the consent doctrine is the EU General Data Protection Regulation, according to which consent means «any freely given, specific, informed and unambiguous indication of the data subject's wishes by which he or she, by a statement or by a clear affirmative action, signifies agreement to the processing of personal data relating to him or her»[69].

But what do environmental health data of a data subject amount to under regulation? It seems that under the same Regulation, «personal data concerning health should include all data pertaining to the health status of a data subject which reveal information relating to the past, current or future physical or mental health status of the data subject [...] any information on, for example, a disease, disability, disease risk, medical history, clinical treatment or the physiological or biomedical state of the data subject independent of its source»[70]. This definition could leave space to include data coming from wearables such as those we have seen previously, in data regarding environmental health and thus falling under the scope of Article 9 of the GDPR: «the processing of data concerning health shall be prohibited». But if we consider the substantive collective right to a clean environment to be a fundamental policy consideration, shall processing of data regarding environmental health then be comprehended in the exceptions listed by the same article in paragraph two? Shall processing of those data be considered necessary for archiving purposes in the public interest, scientific or historical research purposes or statistical purposes?[71] Or should it be included in the category of processing necessary for reasons of public interest in the area of public health, such as protecting against serious cross- border threats to health[72] or ensuring high standards of quality and safety of health care? It all depends on how seriously matters as climate change are taken: the balance of rights may shift from consent to an implied consent for public or national security reasons.

[69]See EU General Data Protection Regulation (GDPR), 2016/679, article 4(11).
[70] See *GDPR*, recital 35.
[71] See GDPR, article 9 (2 - j).
[72] See GDPR, article 9 (2 - i).

6.4. Inequality in access to Artificial Intelligence and the Right to Environmental Health

Independently from its impacts on climate change litigation, precautionary concerns and privacy concerns, nations of the globe are funding their race towards Artificial Intelligence supremacy in what has become a new field of cooperation for some and a new arena, in which a proper war is carried out, for others.

The United States, major competitors in the field, are currently engaging in an aggressive free market approach towards Artificial Intelligence by stating that «continued American leadership in Artificial Intelligence is of paramount importance to maintaining the economic and national security of the United States»[73]. In the same summit, Michael Kratsios, Deputy Assistant to the President for Technology Policy affirms: «to the greatest degree possible, we will allow scientists and technologists to freely develop their next great inventions right here in the United States. Command-control policies will never be able to keep up. Nor will we limit ourselves with international commitments rooted in fear of worst-case scenarios»[74].

But in the rush for AI, the US has another strong competitor: China, which is taking major steps towards leading discoveries but does so in a completely different way, to «advance the building of China into a science and technology superpower and a cyber superpower, and help the real economy to transform and upgrade»[75]. The world has some hypothesis on who will win the war but what is sure is someone will win and someone will be left behind. Indeed, Information and Communication Technologies have been revealed as key potential factors for economic growth and social development. The diffusion of ICTs drives access to information and knowledge; the unequal distribution of ICTs within or between societies may result in a very uneven impact on economic development and on wealth.

Technological instruments may be missing due to the institutional structure or type of government, its infrastructure, socio economic status, psychological factors and culture, lack of knowledge and skills, price, speed, content and quality of the service[76]. If these circumstances occur a country risks to have major backlashes in the future, especially because of the unprecedented speed at which the Fourth Industrial Revolution is running.

To have a clear picture of how regions and countries are developing the AI potential: the US is leading with 1393 start ups on its soil in 2018, China takes the second place with 383, followed by Israel, the UK, Canada, Japan, France, Germany, India and Sweden reaching the tenth position[77]. It is very difficult to find any developing country in these types of statistics. The digital divide risks, due to this disproportionate growth, to become an environmental divide: if we use Artificial Intelligence to mitigate climate change, for example,

[73] https://www.whitehouse.gov/articles/accelerating-americas-leadership-in-artificial-intelligence/ (last viewed 22/04/19).
[74] The White House Office of Science and Technology Policy, *Summary of the 2018 White House Summit on Artificial Intelligence for the American Industry,* May 10, 2018.
[75] China's State Council, *A Next Generation Artificial Intelligence Development Plan*, 2017.
[76] C. SRINUAN, E.BOHLIN, *Understanding the digital divide: A literature survey and ways forward,* 2011.
[77] Roland Berger Gmbh Munich, Asgard Capital Verwaltung Gmbh, *Artificial Intelligence - a strategy for European Start ups*, 2018.

how do we ensure the same opportunities are given to all countries affected, even if not able to provide for this type of technology for themselves?

In this regard, the UNFCCC recognises that: «steps required to understand and address climate change will be environmentally, socially and economically more effective if they are based on relevant scientific, technical and economic considerations and continually re-evaluated in the light of new findings in those areas»[78].

This means there might be room to say that Artificial Intelligence, due to its benefits, has to be taken into account in this continuous re-evaluation and, most importantly implies that if this re-evaluation does not take place in all countries or in a coordinated effort at the international level, the result will be a lower effectiveness in addressing climate change. A solution for enhancing equality in access to Artificial Intelligence may be the one of applying the framework used for climate technologies transfers from developed to developing countries, precisely under the UNFCCC and subsequent agreements. AI could fall under these climate technologies, which are defined as any equipment, technique, practical knowledge or skill needed to reduce greenhouse gases emissions or to adapt from climate change[79] and under the Paris Agreement «parties share a long-term vision on the importance of fully realising technology development and transfer in order to improve resilience to climate change and to reduce greenhouse gas emissions»[80].

A mechanism implementing this commitment is the Technology Needs Assessment (TNA): since 2001, more than 80 developing countries have submitted their assessments to communicate their technology needs to address climate change. A successful example based on Artificial Intelligence application is represented by Bhutan's Technology Action Plan, setting specific targets for the period 2013-2018, with the goal of implementing Intelligent Transport System technologies in the existing Regional Transport Offices[81]. In recent years, the Kingdom of Bhutan has experienced increasing population growth and migration into urban areas and this growth has had a major impact on the transport sector and mobility needs of its citizens resulting in more private and public vehicles on the roads and leading to an increase in congestion, air pollutants, noise pollution, traffic accidents and greenhouse gas emissions. Greenhouse gas emissions from the transport sector were identified as the highest (44%) in energy related greenhouse gas emissions in Bhutan and are mainly due to fuel combustion. Moreover, the number of vehicles registered in Bhutan is increasing at an average of 10% annually, leading to further greenhouse gas emissions growth from this sector in future. To address this growing problem, the country's Technology Action Plan identified Intelligent Transport Systems, which are designed to improve the operational and managerial efficiency of transport systems leading to a reduction in associated greenhouse gas emissions, as a priority technology.

[78] UNFCCC, Preamble, 1992.
[79] http://unfccc.int/ttclear/support/technology-mechanism.html (last viewed 22/04/19).
[80] Paris Agreement, *Article 10 (2)*, 2015.
[81] S. Bee, S. Traerup, V. Hecl, *From needs to implementation: stories from the technology needs assessment*, 2017.

Mechanisms such as this enhance transparency and effectiveness in the fight against climate change: if we do not take the necessary measures, an unregulated free market approach to Artificial Intelligence, led by developed countries only, will surely give priority to much more profitable applications, with no interest in the public good. It is fundamental thus, that the AI dialogue reaches its potential to be a global dialogue, because positive consequences are going flow from it. As stated by The Department of Economic and Social Affairs of the United Nations Secretariat in the World Economic and Social Survey of 2016: «the imperative of limiting global warming together with the task of effectively reducing the impact of climate hazards on vulnerable populations requires a profound transformation of international cooperation. Much of the previous focus of climate action has been on mitigating the effects of anthropogenic activity so as to limit the rise in global temperature. In addition to this effort, unprecedented levels of cooperation in a number of critical development areas are needed for the specific purpose of achieving climate change adaptation».

7. Concluding remarks

As we have seen, the substantial and procedural right to environmental health, if accepted in a legal system, leads to the assumption that the best technological remedy available to mitigate or avoid harm related to bad environmental conditions or effects of climate change should be used. This search for the best possible technology is leading scientists to Artificial Intelligence: is this the right instrument to provide guidance and case by case solutions in environmental law? It seems AI's potential is huge and it seems that research is not going to stop or be limited by any sovereign state, an exception being the European Union block of states, which is aiming at bringing Europe's ethical approach to AI to the global stage. At the same time, we are at a point in history when, at the international level of sovereign states, there is broad consensus on causes and effects of climate change, when decarbonising economy and society has finally reached the level of a realistic and necessary proposal. AI can be the right instrument to connect the dots and work in collaboration with policy makers, judges and lawyers, to have a system including environmental protection as the top priority, based on scientific observation. But being an instrument with a probability of error, Artificial Intelligence is also not completely predictable and putting in its hands the Earth's future might be risky. That's why we need to ensure cooperation does not represent substitution of the human, at least formal, explicability, until it's not clear whether precaution towards AI can be diminished. The probability of error of the AI instrument must thus be clear and specified to the human who makes use of it. To take a human centric approach is important; the human mind is what AI is inspired by, but to put humanity first is to put the environment first, too. Conservation of the Earth means conservation of humanity: the Fourth Industrial Revolution should be enhanced by the international

community of states and by the single mind only if preconditions such as a complete decarbonisation are comprehended in the picture.

AI risks, as analysed, range from probability of error to increasing economic and digital divide and polarisation of society, which is an element to reflect on. Polarisation means, in practice, two sides of society exchanging opposing views on a matter: there can be cooperation, a synthesis of problem, or complete divide. When the divide persists, «individual conscience is increasingly seen as the battleground of choice for a conflict that is self evidently a problem of the global commons, requiring collective action: it is as if every other resource of democratic governance had been exhausted leaving only this residue: the moral».[82] That is precisely why climate change adaptation and mitigation and environmental preservation must be tackled with the right instrument: to avoid the common sense that innovations such as AI will solve the problem instead of us, acting as humans, collectively, to avoid that morals become everything that is left. For this reason words such as the ones by U-Thant, Secretary of the UN present at the first Earth Day in 1970, leave us still complicit: «As we watch the sun go down, evening after evening, through the smog across the poisoned waters of our native Earth, we must ask ourselves seriously whether we really wish some future universal historian on another planet to say about us: with all their genius and with all their skill, they ran out of foresight and air and food and water and ideas or they went on playing politics until their world collapsed around them»[83].

[82] A. GHOSH, *The great derangement,* cit., 132.
[83] UN Secretary U-Thant, *Speech at the United Nation's first Earth Day*, 1970.