THE LIGHT OF CIVILIZATIONS FOR GLOBAL SUSTAINABLE DEVELOPMENT

Jean-Paul Ngome Abiaga,

Ph.D in Mathematical Physics
UNESCO (Paris, France)
E-mail: jj.ngome-abiaga@unesco.org

The United Nations 2030 Agenda for Sustainable Development is a global policy framework set for countries to tackle poverty, realize the human rights of all, and to achieve gender equality and the empowerment of all women and girls, inter alia, through science, technology and innovation. It is observed that in the history of humanity scientific leapfrogs were often possible owing to the investment and large diffusion (conservation, translation and sharing) to a greater number of people of science knowledge. This propitious environment for the development of new ideas and concepts, participating in the development of the society, was catalyzed by a formal or informal large policy framework in specific space and time. From kings to low socioeconomic populations, quality science and culture educations, as promoted by UNESCO, must be shared by a large number of citizens. Sometimes advances in science may appear need-based or curiosity-driven, that they actually arise thanks to a fertile ground for intellectual development and collective improvement, made possible by specific political, economic and cultural frameworks in place in a region in a period of time. The present article analyzes and compares the different societal contexts that fostered the progress in science, technology and innovation in the history with our current global policy framework for sustainable development.

Key words: science education; history of science; science for sustainable development; science-policy society interface; women in science; science and culture.

Introduction

The United Nations recently adopted 17 Sustainable Development Goals and 169 targets demonstrating the scale and ambition of this new universal Agenda, based on the three pillars of sustainable development: the economic, social and environmental. This 2030 Agenda seeks to end poverty, realize the human rights of all and to achieve gender equality and the empowerment the world citizens, therefore playing the role of a global policy framework for the betterment of all societies.

In this context, the United Nations Educational, Scientific and Cultural Organization (UNESCO) – "the intellectual agency" of the United Nations system − is contributing to this global agenda as a spearhead in knowledge production, science advocacy, and in science standard settings on a global scale. As an example, UNESCO was the agency leading the International Year of Light and Light-based Technologies (IYL), following the corresponding United Nations (UN) General Assembly Resolution (A/RES/68/221). The Year promoted the scientific, educational and cultural values of light, and emphasized on the importance of light science in the service of sustainable development. Under the coordination of UNESCO's International Basic Sciences Programme (IBSP), a bright spectrum of novel activities were first implemented in 2015 (and continue today), and established activities provided a renewed impetus to the theme of light and light-based technologies and innovation for development.

At the nucleus of life, light has been an object of interest since the beginning of the human species, from the basic observation of stars to the discovery of fire thousands of years ago. The fascination and determination ignited has led to hundreds of scientific discoveries since. Light and related innovations have provided major scientific and cultural turning points in countless ways. Light as a symbol also has a crucial cultural role. Flamboyant Gothic cathedrals, for example, are one of the most impressive technical and artistic accomplishments in late Medieval time, characterized by large windows which allow light to stream in and the surrounding stone to take on the appearance of lace with the play of light. Through such works, loaded with symbolic meaning, it is easy to imagine why Gothic architecture is identified as a central symbol of transition from the Middle Ages to modern time in Europe. Similarly, light had every importance in Medieval Timbuktu in West Africa, which was famous as a great centre of Muslim learning during the Islamic Golden Age. The town of wonders lit up at night, with learned students and lecturers roaming the streets - Arabs, Jewish, Berbers, Southern Europeans and Mandingo merchants mingling among others − and with riches such as decorated books, drapes with deeps dyes, gold objects and products reflecting light like the salt sold in the region. Damascus, Cairo and Baghdad during the Islamic Golden Age can be imagined similarly. Through its very omnipresence, light would no doubt have a complex, awe-inspiring and changeable role to play in any great city in history, whether it be in the Middle East, in North and West Africa, in Europe and worldwide. Light has always played a crucial role in every geographical location and context, whether we focus on the scientific or cultural relevance. It was therefore timely for the international community to celebrate an International Year of Light and Light-based Technologies, building on the long thread of achievements in the history of light science in order to imagine and create a sustainable future.

Main material statement

The International Year of light and light-based technologies arose in the particular context in which the international community is turning to implement the United Nations 2030 Agenda for Sustainable Development [Transforming our world]. Light science and light-based technologies are indeed directly or indirectly related to the effective delivery of the 17 Sustainable Development Goals (SDGs) adopted to create a prosperous and sustainable society. Leading solutions that offer practical, sustainable and cost-effective alternatives are often light-based. This is particularly relevant for the developing world, and the most disadvantaged regions, when it comes to advancing science education and research (SER), water-food nexus, diseases alleviation, access to energy, poverty and climate change mitigations. Successful experience demonstrates that light will indefinitely be in the service of humanity and the environment, and thus it is imperative to manage resources and enable the capacity development of populations through responsible application and use of light and light-based technologies. An example of such cutting edge technologies working towards the SDGS are LEDS, which − by bringing an environment-friendly lighting −contribute to chasing the "darkness" by improving lifestyle, education and employment opportunities. UNESCO intends to contribute to this objective through identifying and strengthening all possible levers that foster the attainment of the 2030 Agenda.

Diversifying economies through science-driven policies, sustaining human capital development in sciences, supporting innovation hubs, and ensuring public and private investment, and improving the mobility of researchers are key elements towards progress and sustainable development. In addition, improving public and private partnerships is essential and contribute to so many developmental levels. As light shines at its brightest today, only in the present can steps be taken to improve for future generations. One recognizes here the pivotal role of shared global and regional frameworks in driving the developmental process of countries, in view of "chasing the darkness" represented by poverty. Nowadays, this global policy framework can be identified by the United Nations 2030 Agenda for Sustainable Development.

To chase the darkness was a constant objective in the history of humanity. It therefore was opportune for the IYL to revive in the minds of women and men the impact of ancient scientists in the rising of modern society. Indeed, the history of humankind is marked with scientific discoveries related to light, which were stepping stones for the future. Many were stimulated by curiosity, as well as by daily or immediate needs, but all arose thanks to fertile grounds for intellectual development and collective improvement, which are comparable to regional policy frameworks.

Observing history, one may point to such discoveries, scattered across periods and geographic areas. For instance, the Egyptians were among the earliest master mathematicians in North-East Africa using unit fractions as seen in documents dated back from the 12th Dynasty (circa 1990 BC) [Imhausen, 2006]. This also is portrayed by the great precision and proportions of the pyramids and other sophisticated architecture, as well as the associated graphics and icons that remain from the Egyptian civilization. The importance of such discoveries are as much cultural as they are scientific. Miles away in ancient India (circa 322 to 185 BCE), the Indians conceived a system of weights and measures [Allchin, 1995], and soon after used decimals, the place-value system [Ifrah, 1998] and an approximation of "Pi" developed by Aryabhata during the Indian Classical Age [Jacobs, 2003: 70]. The latter would later become the international standard. The Iron Age is another era among the many we can identify that demonstrates scientific innovation, driven by gradually acquired know-how, though often recognized as more of a cultural than a scientific development. This era marked a turning point with the widespread use of tools and objects made of iron for increasingly practical living. Global changing cultural practices for humanity as a whole accompanied these daily transformations.

Other examples of innovation that served as catalysts for future generations include the navigation compass invented in China during the Han Dynasty (206 BC to 220 AD), which was used along with the astrolabe (one of the oldest navigation tools), and other useful contraptions during the Age of Exploration and Discovery (from the 15th Century to 17th Century), when humans travelled the seas with improved vessels and techniques, seeking the Other World [Lowrie, 2007: 271]. Hence, scientific innovations of great value, conceived at one point in time, often resurge to serve future generations. This was made possible because of a specific political, economic and cultural framework in place in the Renaissance.

The Islamic Golden Age (from the 8th Century to 13th Century) is a prolific period in space and time, which represents a stepping stone for humanity with numerous "quantum leaps" in many scientific fields. These would serve future researchers, including the medical and health fields. One prominent example is the Persian Avicenna's Canon of Medicine (1025 AD), which remained an authority up until the 18th Century in Europe. Other prominent examples include: in the 10th Century is what is now modern-day Iraq, Ibn Sahl was the first to accurately describe the law of light refraction. Al Khazini compiled knowledge in relation to hydrostatistics and medieval mechanics in an encyclopedia entitled "*The Book of the Balance of Wisdom",* and was the important discoverer of altitude air density in the 12th Century. Avempace (Ibn Bajja) had an influence on game-changers such as Galileo Galilei, who six centuries later, owing to the heritage he left behind, also contributed to the erudite and holistic approach to science in the Islamic Golden Age carried by certain exceptional individuals at the time.

More prominently, Ibn Al-Haytham (also known by his Latinised name Alhazen or Alhacen) − a 10th century scholar from Basra in contemporary Iraq, and dead in Cairo (Egypt) − is considered as the father of modern optics and the pioneering figure of the scientific experimental methodology, which he proposed centuries before the Renaissance scientists [Ackerman, 1991]. Ibn Al-Haytham's works and publications deeply influenced scientists and philosophers from the Renaissance period and formed the backbone of notable advances in mathematics and physics made by Kepler, Descartes and Huygens to cite a few [Rashed, 2007; Zewail & Thomas, 2010].

That is why in a commemorative spirit, UNESCO drew attention during the IYL to the sometimes ignored contribution of polymaths, at the example of Ibn Al-Haytham, from the Islamic Golden Age of Science, most significantly by hosting at its Paris Headquarters (from 14 to15 September 2015) an international conference, "*The Islamic Golden Age of Science for Today's Knowledge-based Society: the Ibn Al-Haytham Example". This international conference* focused on the accomplishments of the Islamic civilization in its Golden Age and the life and works of Ibn Al-Haytham, whose pioneering "*Book of Optics (Kitāb al-Manāzir)"* was published some 1000 years ago. Other historical figures, such as Al-Sufi, notably remembered as an astronomer, or Ibn Rushd, a well-rounded polymath, were also honoured during the event. We believe that the "Ibn Al-Haytham conference" will be continued to become a triennial meeting focusing on the contribution of diverse civilizations to societal development.

Historians often comment on an intellectual revitalization of Western Europe with strong philosophical and scientific roots, particularly in the 12th Century, setting foundations for the centuries to come. This is owing to rekindled ties at the time, not only to Greek Antiquity, but also prominently with the Islamic world. It is therefore essential in the 21st Century that global society recognize the contribution of multiple civilizations to the development of science, and of light-related sciences and technologies in particular. Marking the beginning of modern times, the industrial era was triggered by technological innovations.

The new scientific know-how led to the development, *inter alia*, of the factory system and large-scale manufacturing. Owing to such development, there was a general rise in income for a portion of the population, new upper and middle classes formed and a progressive uplift in societal rights arose. In many cases, from the examples of the past and most particularly nowadays, one may observe that scientific progress is possible owing to the investment and large diffusion (conservation, translation and sharing) of science and quality education to a greater number of people. This again is possible only through an engagement, in the form of a shared large policy framework, within and of the whole society (from kings to low socioeconomic populations) towards quality education, science and culture, as promoted by UNESCO.

It is a certainty that science developments in the service of societies require increased efforts to create educated workforces − women and men who will make the most of investments to carry their countries development. One may also perceive that a major driver of progress throughout the ages is human ingenuity and opportunities linked to current needs, which can be nurtured through propitious intellectual environment. Today through increased investments in quality science education for society, light serves as a great instigator that unites these forces of curiosity and needs-based demands, as well as offers in education.

Amidst existing developments and innovation, UNESCO aims to support the development of societies by building partnerships for investment in science and quality education, including light sciences, which offer countless solutions for contemporary challenges. UNESCO contributes to efforts to strengthen education in the basic sciences in particular through capacity-development, such as workshops dedicated to light sciences, namely the UNESCO Active Learning Optics and Photonics (ALOP). Indeed, since 2005, and strengthened during the IYL, UNESCO's IBSP, ICTP and SPIE jointly implemented the ALOP Programme in various regions of the world, particularly in places where the educational resources are lacking. Since its inception, these workshops have served over 1,650 teachers from more than 55 developing countries in Africa, Asia, and Latin America. The ALOP serves as a remarkable basis to further learning and curiosity-driven experimentations in scientific fields through various axes, which tackle challenges linked to education and learning.

As the IYL demonstrated, light and related discoveries are one of the greatest of all scientific considerations. This is observable across all scientific fields, from biology, physics, chemistry, and mathematics; all consider light a central element in the experience of life. From the biological phenomenon of photosynthesis − without which life on earth would be impossible − to the dispersion of light through raindrops that form a rainbow (studied mathematically through Snell'− Descartes' law), the omnipresence of light is evident. Light has a vital role in providing us with vision as Ibn Al-Haytham has proven it, and simply revives or senses through the perception of shapes and colors as one may experience in contemplating fireworks or a Picasso painting.

History has traced light science developments and the impact on the world's societies. It is indeed useful at times to be reminded of the gift of light in order to further appreciate its value. It is also important to turn to history − in order to develop awareness for the future − on how we have arrived at our current understanding of light. That is why the achievements of Ibn Al-Haytham should be celebrated and preserved, not only by UNESCO, as with the Ibn Al-Haytam Conference, but also through a global partnership towards the use and application of light technologies for the benefit of each and every individual, and through lasting, sustainable developments for all societies.

REFERENCES

Ackerman, James S. Distance Points: Essays in Theory and Renaissance Art and Architecture. USA: MIT Press, 1991.

Allchin, Raymond F. The Mauryan State and Empire. The Archaeology of Early Historic South Asia: The Emergence of Cities and States. Cambridge University Press, 1995.

Imhausen, Annette. Ancient Egyptian Mathematics: New Perspectives on Old Sources. The Mathematical Intelligencer, 28(1), 2006: 19–27.

Ifrah, George. A Universal History of Numbers: From Prehistory to the Invention of the Computer. London: John Wiley & Sons, 1998.

Jacobs, Harold R. Geometry: Seeing, Doing, Understanding (Third Edition). New York: W.H. Freeman and Company, 2003.

Lowrie, William. Fundamentals of Geophysics. London: Cambridge University Press, 2007.

Transforming our world: the 2030 Agenda for Sustainable Development. 2015. http://www.un.org.ua/en/publications-and-reports/global-un-publications/4337-transforming-our-world-the-2030-agenda-for-sustainable-development-2015

Zewail, Ahmed H.; Thomas, John Meurig. 4D Electron Microscopy: Imaging in Space and Time. World Scientific, 2010.