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Editorial

Preface to "Physical Agents: Measurement Methods, Modelling and Mitigations"

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1. Introduction

Physical agents (noise, vibration, ionizing, and non-ionizing radiation) are playing an increasing role in environmental protection and health. Urban noise and vibrations disturb hundreds of millions of citizens, causing measurable health effects. The recently published WHO Environmental Noise Guidelines for the European Region showed stronger evidence of cardiovascular and metabolic effects [1]. Modeling has a relevant role to determine noise exposure, according to the 49/2002/CE directive [2] guides mitigation process in the actions plans due by law [3,4]. Noise sources characterization and emission measurement methods take advantage of new techniques and instrumentations, such as beam forming, array detectors, etc. Big data processing [5] and distributed sensor networks will enable tremendous improvement in the spatial and temporal knowledge of sound levels. Human perception of and response to noise provide another perspective in the evaluation of annoyance [6] and open new roads to understand how to design new spaces for the public.

Among physical agents, ionizing radiation is certainly by far the most harmful threat for public health. Actually, the adverse effects of human exposure to the radiation emitted by radionuclides or by X-ray equipment were already well recognized at the beginning of the 20th century. Radiation protection principles have become well established over the decades and the legislation of most states are all based on very common recommendations and standards. Regarding this matter, an important role is held by ICRP (International Commission on Radiological Protection), a prestigious non-governmental organization composed of the most eminent international experts. *The* ICRP Recommendations [7], periodically issued, are usually the guidelines for updating the legislation all over the world (see for example, [8]). Today, the most prominent issues in the field of ionizing radiation are the managing of radioactive wastes, especially related to the decommissioning of nuclear power plants and the exposure to natural radioactivity (NORM, naturally occurring radioactive material and radon). However, the study of ionizing radiation and, in particular, of environmental radioactivity, cannot be limited to radiation protection issues: the presence of natural and artificial radioisotopes in the environment was proven to be a very powerful tool for a better understanding of the complex dynamics in the atmosphere and in all the biosphere compartments [9].

Exposure to non-ionizing radiation is a widespread theme that includes extremely low frequencies (ELF), electric and magnetic fields and radiofrequency (RF) electromagnetic fields (EMF). Regarding ELF and RF fields, there is great concern on the possible effects of mobile phone use or about living close to infrastructure, such as power lines, radio base stations, and broadcasting towers. The rapid growth and development of the telecommunication technology enhance the urgency of setting up new methods to evaluate human exposure. With the upcoming standardization of 5G radio access technologies, there is a clear need to develop specific procedures for RF EMF exposure assessment. Two of the main

technical standard bodies, the IEC and IEEE, are working to harmonize electromagnetic field safety compliance assessment standards for 5G devices [10]. Furthermore, a revision of the current ICNIRP (International Commission on Non-Ionizing Radiation Protection) Guidelines for limiting exposure to radio frequencies has been recently published [11] and new limits have been established on the basis of recent advances in the scientific knowledge on radiofrequency health effects.

Solar ultraviolet (UV) radiation can cause many adverse effects on health, such as skin cancer and cataracts, and is the most important environmental risk factor for the development of non-melanoma skin cancer. Accurate measurements of solar UV radiation are needed to evaluate the exposure of people and workers [12,13]. High quality ground base measurements are also useful to track the changes of solar UV, due to the depletion of the ozone layer [14]. UV exposure assessment by personal dosimeters or spectrometric measurements of solar UV irradiance are challenging themes in the field of protection against UV radiation [15].

2. Highlights

In this Special Issue, the best 12 papers presented in the VII National Conference on Physical Agents held in Stresa (Lago Maggiore, Italy, 5–7 June 2019), jointly organized by AIRP (Italian Radiation Protection Association) and ARPA Piemonte (Environmental Protection Agency of Piedmont, Italy), were published after the international review process.

A large number of research topics are covered by the papers of the Special Issue:

- Noise control
- Quiet areas and their acoustical characterization
- Port noise
- Environmental radioactivity
- NORM exposure
- Nuclear decommissioning monitoring and nuclear waste production
- Interference of electromagnetic fields with active implantable medical devices (AIMD)
- Radiofrequency interferences in weather radars
- Radiofrequency electromagnetic measurements
- Solar UV irradiance

2.1. Acoustics

In [16], noise measurements are presented as referring to several areas in Aosta Valley, an alpine region in north-west Italy that is characterized by a high level of naturalness. Anthropogenic noises due to touristic activities related to sky resorts overlapped to the sound of nature. A large number of indicators are used to elaborate noise data to describe the change in the soundscape of the areas and seasonal variations.

In [17], Bolognese et al. investigated the port noise in the framework of the INTERREG Maritime program projects RUMBLE, MON ACUMEN, and REPORT. Authors described the complexity of a harbor, open to commercial, industrial and touristic activities, and presents a difficult scenario in assessing citizen noise exposure. They underlined the lacking of laws that issue limits and noise mapping at national and European level and, above all, of guidelines for evaluating the port noise impact. A survey was conducted on measurements' campaigns, monitoring systems and the management of complains in the area interested by the projects. Authors highlighted the absence of noise actions to reduce the increasing noise coming from a source in rapid development.

2.2. Ionizing Radiation

Measurements of low-level radioactivity were initially driven in the early sixties of the last century by the needs of monitoring the effects on the Earth of the nuclear weapons testing activities during the Cold War. Nowadays, the detection of small traces of radionuclides, either artificial or natural,

are more often used to investigate the complex dynamics of the atmosphere and of the ecosystems. Paper [18], dealing with the measurements of natural cosmogenic radionuclide ^{22}Na in the atmosphere, is an example of such studies: the work provides a method for the reconstruction of ^{22}Na time series from previously acquired gamma spectra. Authors highlighted some considerations on the correlation between the radionuclide concentrations and the solar cycles.

Fertilizers are included among NORM, because they can increase the radiation exposure of the population, due to the possible presence of high levels of natural radioactivity. Ugolini et al., in [19], investigated the dosimetric impact on the population, due to the cumulative use of fertilizers. Considering the most widely used fertilizers in Italy, authors used a specific software package for the dose assessment.

Sandri et al. in [20] explore, from the radiation protection point of view, the new scenario of the experimental nuclear fusion facilities. They particularly focused on the tokamak-type nuclear fusion devices, such as DTT (Divertor Tokamak Test) and ITER (International Thermonuclear Experimental Reactor), now under construction in Italy (Frascati) and France (Cadarache).

One of the main radiation protection problems arising from the decommissioning of nuclear power plants (NPP) and other nuclear installations is the issue investigated by Albertone et al. in [21]. In particular, authors discussed the clearance criteria and its practical implementation for the wastes produced during the dismantling of a nuclear installation, using the radionuclides scaling factors as practical tools for clearance levels compliance.

2.3. Non Ionizing Radiation

The unintentional reception of electromagnetic energy can be related to unwanted effects, such as electromagnetic interference (EMI), in several types of operational equipment. The interference of EMF on active implantable medical devices (AIMD) can cause dangers to individuals bearing these devices. Mattei et al. in [22] investigated the interference phenomena in pace makers exposed to three different EMF sources used in working environments. The results presented in this study show an experimental methodology for performing the risk assessment for workers wearing cardiac pacemakers.

Radiofrequency interference can have a great influence on the weather radar data quality. An experimental method to detect the interfering sources at C-band weather radar is discussed in [23]. In this study, a survey of electromagnetic interferences in weather radars is reported on, with the aim to show the interference phenomena at different frequencies in northwestern Italy.

The assessment of human exposure to electromagnetic fields has to be based on accurate measurement techniques. Interlaboratory comparisons are reliable mechanisms to ensure the accuracy of measurement results delivered by the laboratory. Ardoino et al. in [24] described an interlaboratory comparison on measurements of electromagnetic fields emitted from long term evolution (LTE) mobile systems (4G signals). The results of measurements carried out by the 27 laboratories participating in the circuit are presented and discussed. The main interest of this work consists in the adopted methodology, which was implemented for comparing measurements of complex LTE signals emitted from a base station in actual operating conditions.

The deployment of fifth generation (5G) networks requires the development of exposure assessment methodologies. In [25], Franci et al. showed a new measurement technique for exposure assessment to electromagnetic fields radiated by 5G systems. The proposed approach was confirmed by a preliminary experimental investigation carried out in a controlled environment.

The non ionizing radiation spectrum includes ultraviolet radiation, which comes from the sun, as the main source. In [26], Fountoulakis et al. presented a review of studies on the influence of aerosols, cloudiness, and surface albedo on the solar UV irradiation that reaches the earth's surface. The work is focused on the importance on having long-term, accurate UV measurements, which can provide useful information in the context of changes in air quality and climate.

Italian experiences on the primary prevention of skin cancer caused by exposure to UV radiation are showed in [27]. Several preventive actions are described, which aim to reducing the risks for workers exposed to solar radiation and for people using sunbeds.

Conflicts of Interest: The authors declare no conflict of interest.

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