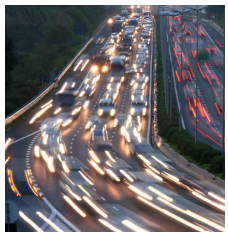
CHAPTER 5

EXPOSURE TO PHYSICAL AGENTS

Noise
Electromagnetic Fields
Ionising Radiation



Introduction

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A physical agent is by definition the element that, governed by the laws of physics, brings about a change in the environmental conditions of the context in which it is exhibited. Its presence in living and working environments determines the energy that is emitted and which is potentially detrimental to human health. Physical agents that effect the environment are electromagnetic fields, environmental noise and noise inside working places, ionising radiation, vibrations, light pollution and UV (ultraviolet) radiation.

Noise pollution is characterized by widespread and an elevate impact it has on the environment, on eco-systems and on the population and is significant enough to induce the EU to pursue as an objective, the reduction of the number of people exposed to noise.

Noise pollution is characterized by widespread and an elevate impact on the environment, on eco-systems and on the population. The bothersome or disturbing effects it causes have been well-documented and are such that the European Community has been persuaded that reducing the number of people living its member states exposed to noise must be a primary objective achievable by specifying the methods and instruments to be adopted to quantify and manage noise levels. The detailed legislation on this subject and the existence of measures devoted to preventing or reducing noise levels, have not however resolved an environmental issue that remains a priority.

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There is still greater social concern about electromagnetic pollution however, and the effect it is feared it has on human health despite the fact that at national level, the risk connected with prolonged exposure is considered to be low, in part because cause and effect between exposure to electric, magnetic and electromagnetic fields and any subsequent consequences to health has not been established. Legislation regarding this sector has also resulted in specific regulations aimed quite clearly at safeguarding the individual.

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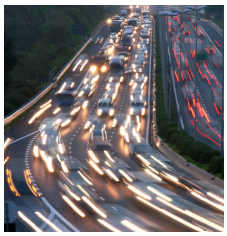
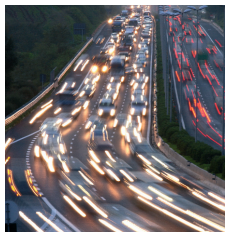
Interaction with biological tissue can result in possible cell damage, in the form of morphological or functional alterations to the organs concerned, as well as medical consequences that can be clinically observed in individuals that have suffered exposure. Although there are no nuclear plants in operation in Italy, the pressure on the environment caused by ionising radiation continue to



be both relevant and numerous: the production and necessary treatment of radioactive waste brought about by diagnostic and/or radiotherapy procedures carried out in hospitals, the growing production and worldwide circulation of radioactive materials and radiation of natural origin (radon and NORM) which continue to constitute the main source of exposure, call for radiation-protection capacity to remain a key element of the environmental safeguards and the protection of the population and workers. The risks, deriving from a decrease in the attention and the capacity to control the levels of radioactivity in the environment and in foodstuffs, could inevitably lead to uncontrollable social and economic situations.

Less attention is paid, by both the public at large and legislators, to other agents, and this would seem to be because the impact they have on man and the environment is perceived differently or as being less significant. Vibrations, for example, disturb an extremely limited percentage of individuals and only in very specific situations (the proximity of certain types of transport infrastructures) and light pollution does not create any easily apparent discomfort to the individual. UV radiation warrants separate consideration as the health implications are particularly noticeable in terms of the damage excessive exposure this type of radiation causes to the skin and to the eyes. With the exception of occupational exposure to UV rays emitted by artificial sources, exposure to the Sun, the most significant natural source of such rays, has not yet been formally regulated. Both national and international institutes confine themselves to merely recommending, in opportune notices published in the press, what protective measures should be taken and to providing bulletins about UV levels. These use a number scale to indicate the risk factor incurred by direct exposure of the skin to the sun's rays relative to the subsequent short term effects such as irritation (common sun-burn). The information included suggests the use of protection (sunglasses, protective clothing, creams etc.) and maximum exposure time according to skin type (phototype) and the health risks incurred by an individual are not stressed at all. When it comes to long-term effects (skin cancers and malignant melanomas), these cannot be avoided altogether, but they can be limited by

The medical consequences of being exposed to UV radiation are particularly evident when it comes to the damage this causes to skin and eyes. To date, no actual laws have been passed to regulate exposure to the sun which is the main natural source of this type of radiation.



minimising exposure as much as possible (and, for melanomas, the number of times an individual suffers sunburn).
In any event, it must be borne in mind that corrective measures on this point would be difficult to impose in that these would impinge on an individual's habits and limit personal behaviour that is, conversely, a source of satisfaction (for example tanning in the summer or artificial tanning).

NOISE

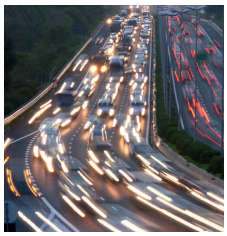
The problem

Noise pollution is one of the most significant environmental problems of all and is such that the European Community has identified reducing the number of people exposed as a priority objective.

Having identified noise pollution as one of the most significant environmental problems, reducing the number of people exposed to noise levels believed to have a detrimental effect on the quality of life and health of its citizens is now the European Community's main objective.
The data relating to the percentage of the population exposed to noise levels high enough to create annoyance or disturb reveals that the number of people exposed is indeed significant.
European Directive 2002/49/EU relating to the assessment and management of environmental noise, transposed into Italian legislation with Legislative Decree no. 194/2005, defines the methods and indicators by which noise pollution can be measured and managed in order that that the data from all member states is produced and provided in a comparable and uniform manner.
Creating harmonization between the national legislative tools and the methods adopted by the Community is the main task to achieving the unequivocal identification of the methods and tools to be used in the planning and management of environmental noise pollution.

It is obvious that the general public is extremely concerned about personal and environmental safeguards: 79 out of 100 complaints are made by the public and of these, 49% of the noise sources reported prove to exceed permitted limits.

The control activities carried out by the Environmental Agencies System, performed primarily in response to complaints presented by citizens, demonstrate an increased concern with this environmental issue, and at the same time confirm that the legal limits are not only succeeded but in many of the situations reported, even reach critical levels. Out of 100 controls performed, 79 result from complaints made by citizens, in percentages that vary among the different sectors: 86.3% of



these cases involve service or commercial operations and 27.8% transport infrastructures. 47% of the noise sources reported by citizens prove to exceed the permitted limits showing that the situation is indeed critical .
The data shows the type of noise sources that citizens find particularly disturbing. Of the 3,614 sources checked, the greatest number, namely 48.2%, deal with those produced by commercial and service activities, followed by productive activities that account for 35.4% and roadway infrastructures at 9.7% (Figure 5.1).

The noise sources checked and that the general public find extremely disturbing relate to commercial and service activities (48.2%) productive activities (35.4%) and roadway infrastructures. (9.7%).

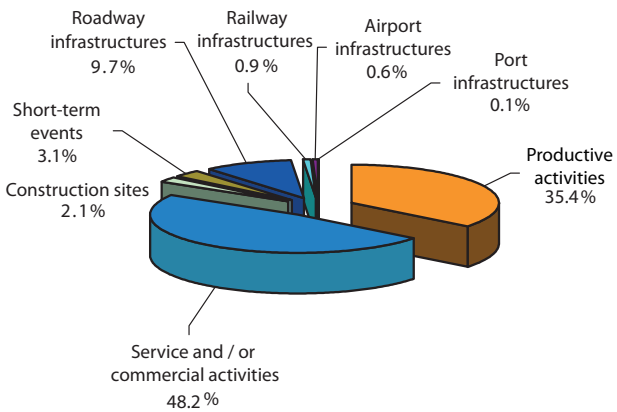


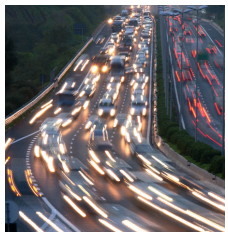
Figure 5.1: Distribution of the sources controlled (3,614) amongst the different types of activities/infrastructures (2007)[1]

The main sources of noise

The main sources of noise, identified as road, rail and air traffic, have all registered a general increase in volume, with distinctive characteristics of the rise that are linked to individual sources. Data pertaining to airport traffic in particular showed a percentage variation of +16.8% in 2007 compared to 2004, whilst motorway traffic registered a percentage increase of approximately

The main sources of noise that have registered an increase in volume have been identified as road, rail and air traffic.

[1] Source: ARPA/APPA data processed by ISPRA
Note: No data is available on the autonomous province of Bolzano or the regions of the Veneto, Lazio, Molise and Campania.



61% between 1990 and 2007. As far as passenger rail traffic is concerned, 306 million trains-km travelled on the State Railway system in 2006 (up 2.5% on 2004), whilst rail freight accounted for 65 million trains-km (up 3.4% on 2004).
The requirement for those bodies responsible for running transport infrastructures to draft Noise Reduction and Abatement Plans, as set out in the Ministerial Decree of 29 November 2000, does not yet appear to have been carried out by all those concerned, although during the course of the previous year many of them have presented the studies that they have undertaken.
The increase in the above-mentioned pressure factors, combined with the shortcomings in the legislation plus the lack of synergy and forms of dialogue between the principal players, is an obstacle to the determination of an organic and shared definition of the action to take.

Shortcomings in the legislation and the lack of dialogue between the principal players create an obstacle to an organic definition of the action to take.

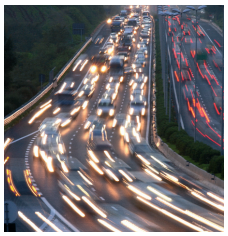
Vehicle traffic represents the main source of urban noise pollution, though other sources should not be forgotten, such as: industrial and small-scale production activities, commercial activities with all their related plants and systems (air conditioning, refrigerators etc.) and discotheques, that have a notable impact on their immediate surroundings.

Actions to limit noise pollution

The existing situation is characterised by the fragmented efforts made to prevent and mitigate the effects of noise pollution, the lack of a coherent approach to legislation and the lack of coordination between those involved. The inconsistencies are evident when comparing different sectors characterised by an articulated number of actions such as transport infrastructures and other sectors that are paid insufficient attention such as construction, territorial and acoustical planning, communications and education on environmental issues.

There continues to be a situation that is characterized by the fragmented efforts being made, the lack of a coherent approach to legislation and the lack of coordination between those involved.

Other factors to consider in the present situation are the undertakings set out in Community regulations regarding new tools specifically designed to manage noise pollution, the introduction of new noise indicators, the attention now being paid to the issue of providing information and the participation of the public at large.

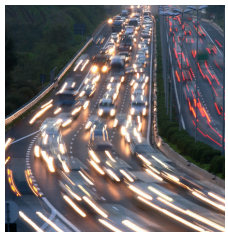


Many initiatives have been formulated in response to the critical state of affairs described. The national lawmaking corpus is close to completion, with the passing of Framework Law no. 447 of 1995 which embodies the obligations stipulated in European Directive 2002/49/EC. The system currently in force, completed by regional laws of transposition, sets out elaborate regulatory measures for specific sources and noise-producing activities. It reveals however that there are considerable inconsistencies in terms of its actual implementation status by the various sectors and in the different territorial contexts. The institutional activities carried out by the Agency System have been intensified in response to the increased demands of the general public. Initiatives are underway to raise the awareness of local government bodies aimed at achieving an accurate and conscious management of preventative measures such as the acoustical classification of municipal territories, and of mitigation, such as the abatement plan, capable of ensuring that all development is acoustically compatible with the territory. Regrettably however, it must be noted that there has been a contradictory response by local administrations, as although some territorial situations are functioning, others are totally inadequate.

Initiatives are underway to raise the awareness of local governments aimed at encouraging preventative measures.

Unfortunately, it must be noted that there has been a contradictory response by local administrations, as although some territorial situations are functioning, others are totally inadequate.

Analysis of the data regarding the fulfilment of the required procedures prescribed by the laws governing the different sectors, shows that in comparison to previous years, the situation in 2007 was stagnant, with little having been done to tackle the current state of affairs. In particular, the fact that many individual regions have failed to pass laws containing measures to deal with noise pollution, as established by the Framework Law, underlines the inadequacy of the response and a fragmentation that characterises the state of affairs at national level. Based on the available data, there are five regions that have not yet passed such regional laws: Molise, Campania, Calabria, Sicily and Sardinia. It should be noted that often, deliberations by Regional Administrations have resulted in measures that deal with individual procedural matters, such as guidelines regarding the drawing up of an acoustic classification or the procedures for certifying an acoustic technician, and these circumvent the lack of a systematic approach at regional level. Regarding acoustical classification, the main tool for establishing how the territory should be used and, therefore the priority initiative in terms of abatement measures, the percentage of



Acoustical classification of a municipal area, the main tool in the preventative process, is not evenly used across the entire country and the frequent failure to explain its usefulness means that the population concerned does not receive accurate information.

Italian municipalities to have approved this classification was equal to 35% in 2007 showing a slight increase over the 31.5% in 2006, while the percentage of the resident population in municipalities that have approved such zoning was 46.4%, compared to 40.8% in 2006. There are notable distinctions in the different regional situations: in the Marche, 94% of municipalities have approved acoustical zoning plans, 88% in Tuscany, 85% in Liguria and 69% in Piedmont whilst the 1% in Sicily, 2% in Abruzzo and 3% in Sardinia are extremely low percentages indeed. Available data shows that in Friuli Venezia Giulia, five municipalities have approved a zoning plan, but following an appeal made by a private company, the TAR (Regional Administration Court) overturned the zoning resolution passed by one of these on the basis that it was passed prior to the issuing of regional criteria and this rendered the implementation of the zoning plans passed by

By 2007, the equivalent of only 35% of all Italy's municipalities had approved acoustical classifications: Marche (94%), Tuscany (88%), Liguria (85%), Piedmont (69%).

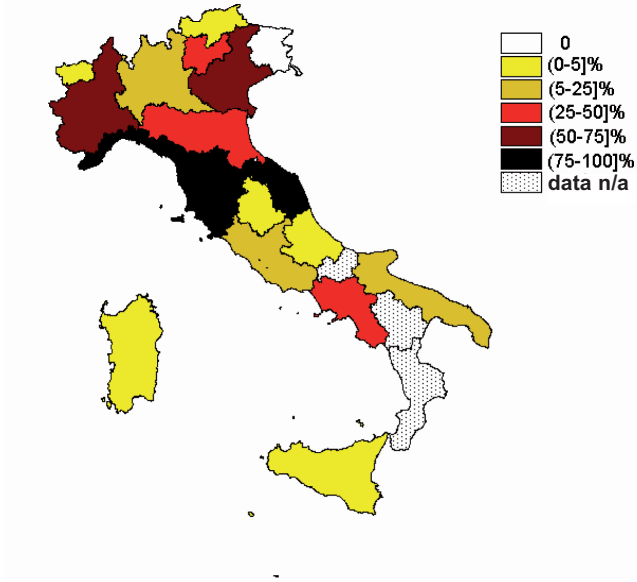
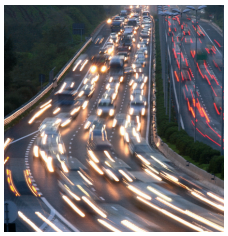


Figure 5.2: Percentage of municipalities that have approved acoustical classifications out of the total number of municipalities for each region/autonomous province (2007) [2]

[2] Source: ARPA/APPA data processed by ISPRA



the other four municipalities impossible. At national level, the territorial surface now encompassed by zoning plans approved by local councils has reached 32% compared with 27% in 2006 (Figures 5.2, 5.3, 5.4). With the exception of Marche, (the only positive note) where 94% of municipalities now have zoning plans compared with a mere 30% in 2006, all the other regions with active preventative policies in place for some time show only a slight percentage increase in both the number of municipalities that have approved acoustic classification and the percentage of population resident, as well as the percentage of the municipal territory included in a zoning plan. A negative note arises from the verifiable territorial differences and contrasts and the realization that some thirteen years since the passing of the Framework Law on noise pollution, the principal means of acoustic prevention and planning is not yet a tool that has been evenly adopted throughout the entire national territory. Its effectiveness is often not publicized and as a result, the population concerned does not receive accurate information.

With the exception of Marche, where 94% of municipalities have zoning plans, there has been only a slight increase in the number of such plans in all other regions.

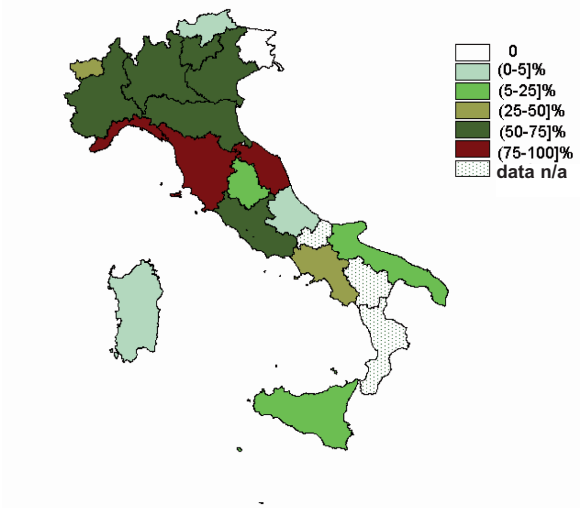
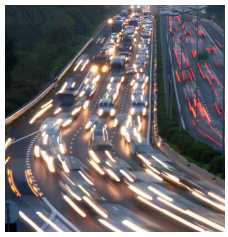


Figure 5.3: Percentage of the population residing in municipalities with an approved acoustical classification out of the total population of each region/autonomous province (2007)[3]

The percentage of the population resident in municipalities that have approved zoning plans reached 46.4% in 2007, showing an increase in respect of the previous year.

[3] Source: ARPA/APPA data processed by ISPRA



The percentage of the territorial surface area of municipalities that have approved classifications is 32%, compared with the 26.3% in 2006.

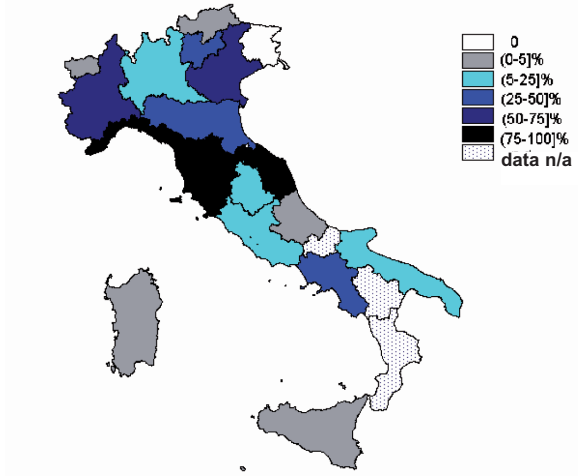
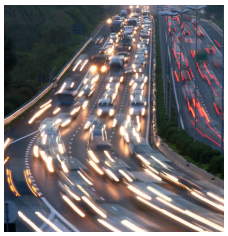


Figure 5.4: Percentage of the territorial surface area of the municipalities that have approved acoustical classifications out of the total surface area of the municipalities in each region/autonomous province (2007)[4]

The obligation to draw up a report on the acoustical status of municipalities at two-year intervals, as established by Law 447/95, an important act for the analysis and management of the problem of noise pollution at municipal level, goes largely unmet, demonstrating the weak response of the municipalities to legislative requirements. Out of a total of 144 municipalities with populations of more than 50,000 inhabitants, that are therefore required to draw up a report, as of 2007 only 21 had approved a report on their acoustical status. Tuscany, with 11 out of 12 compliant municipalities, has produced the most reports, followed by Lombardy, with 4 out of 14. Implementation of the municipal noise abatement plan, as called for under Law 447/95, is not widespread and undoubtedly suffers from insufficient use of other instruments of acoustical planning, such as the municipal acoustical classification, and the failure to pass regional laws on the subject. The available data show that 47 noise abatement plans were adopted, with the highest concentrations in two regions: Tuscany, with 38, and Emilia Romagna with 4.

[4] Source: ARPA/APPA data processed by ISPRA



In 2007, the acoustical classification of the areas surrounding airports, called for under Law 447/95 on the subject of airport noise, was carried out by only 10 of the 39 main national airports although these are being elaborated/evaluated in a further 13 airports at this time.

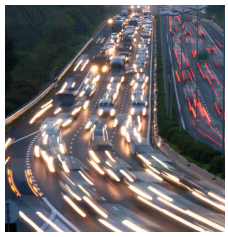
There are distinctions in the abatement measures that managers/owners of transportation infrastructures are required to take under the Framework Law: in the case of railways and the vast majority of motorways, studies were completed on the critical problems presented within their respective infrastructure networks, and an initial series of mitigating actions has been drawn up and programmed, whilst similar efforts for roadways and airports are decidedly behind schedule.

In this current phase, concentrating efforts on the harmonisation and co-existence of methods and instruments introduced by both Community and national legislation to prevent and mitigate noise pollution is what is required, highlighting the conflicts and critical aspects of the situation and defining the solutions to be adopted, so that existing legislation is rendered effective. In light of the information provided above however, the general expectation is that this is unlikely to happen.

The instruments used in the prevention, planning and abatement processes contained within national laws must be made more effective and incisive. This can be achieved by fully enacting the undertakings set out in European Directive 2002/49/EC, in synergy with other initiatives introduced through community regulations.

At present, only 10 out of 39 airports have an approved acoustical classification, the main tool used in planning for airport noise.

Noise abatement and reduction measures regarding railways and motorways is underway, whilst airports and roadways are behind in the drawing up of plans to contain and abate noise.



ELECTROMAGNETIC FIELDS

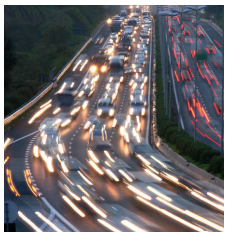
The problem

The prolonged exposure to electromagnetic fields is believed to be potential dangerous.

A significant environmental issue that has become a more pressing part of our reality in recent years is undoubtedly the presence of electromagnetic fields (EMF) and their relationship with both the territory and the population.
The continual development of new telecommunications systems and the intensification of the electricity transmission network that result from the increased demand for electric energy, certainly bring about an improvement to the quality of life but they also often cause environmental problems, and with the risk of conflicts between the general public and the institutions, with can lead to social problems. This predicament, made worse by the public perception that it could be a health risk, must be tackled in a coherent, clear and transparent manner if pointless panic, a response that current medical knowledge would deem unjustifiable, is to be avoided.
As of today, despite the huge strides made to safeguard public health, both in terms of the legislation passed and in technical-scientific expertise, there continue to be heated social clashes between the public and consumer associations on the one hand, and those running the plants on the other, with local government administrators caught in the middle, often along with the control agencies that act as mediators and provide the public with support, without however, losing sight of the rights of plant owners.

The main EMF sources

The sources of electromagnetic fields can be divided into two main categories: low frequency fields (0-300 Hz) or ELF (Extremely Low Frequency) fields, essentially caused by systems for the production, distribution and use of electric energy (electric power lines, substations, home appliances etc.), which, in Italy, are based on the constant industrial frequency of 50 Hz and high-frequency fields (100 kHz - 300 GHz), or RF (Radio Frequency) fields, caused by radio and telecommunications plants (radio, TV, mobile, radar).
In terms of radio and television plants (RTV) and radio base stations (RBS), the environmental impact, meaning electromag-



netic emissions evaluated according to violations of the limits permitted by the prevailing legislation, show respective increases of approximately 6% and 17% between 2006 and 2007. These percentages were calculated, for those regions that supplied complete data, by analysing data from the EMF (Electromagnetic Fields) Observatory .

Between 2006 and 2007, there was a recorded rise in violations of limits by both RTV and RBS plants of +6% and 17% respectively.

Analysis of the data regarding the density of RTV and RBS plants (Figure 5.5) shows that the density of the RBS plants is roughly double that of RTV plants (respectively 0.29 and 0.13 plants per km^2), whilst the density of RBS sites (0.16 sites per km^2) is around five times higher than RTV sites (0.03 sites per km^2).

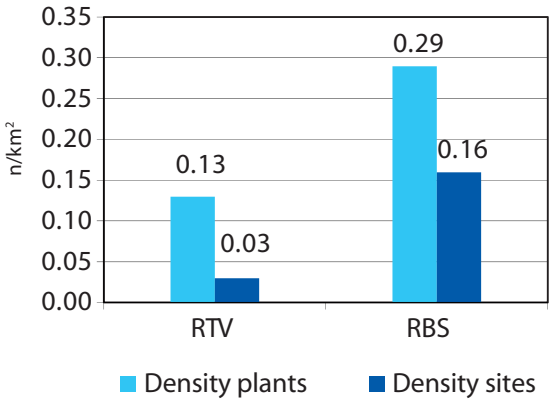
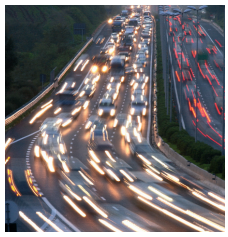


Figure 5.5: Density of plants and sites, a comparison of RTV and RBS for the regions for which full results are available (2007)[5]

It can be seen that the density of the RBS plants is roughly twice that of the RTV plants. There is a similar situation regarding the density of sites as the density of RBS sites is five times higher than the RTV sites.

In terms of the overall power of RTV and RBS plants (Figure 5.6), it is clear that the most significant environmental pressure produced by electromagnetic fields is generated by radio and television plants; in fact, the total RBS power (1,971 kW) is only around 25% of that generated by RTV plants (7,957 kW). The overall lower power levels associated with RBS plants in compar-

[5] Source: ISPRA/ ARPA/APPA (EMF Observatory) data processed by ISPRA



ison to RTV plants means that RBS sites create, as previously highlighted, greater territorial pressure than RTV sites and this is so that the territorial coverage needed to provide a mobile phone service can be guaranteed.

The most consistent form of environmental pressure is caused by RTV plants that are overall four times more potent than their RBS counterparts.

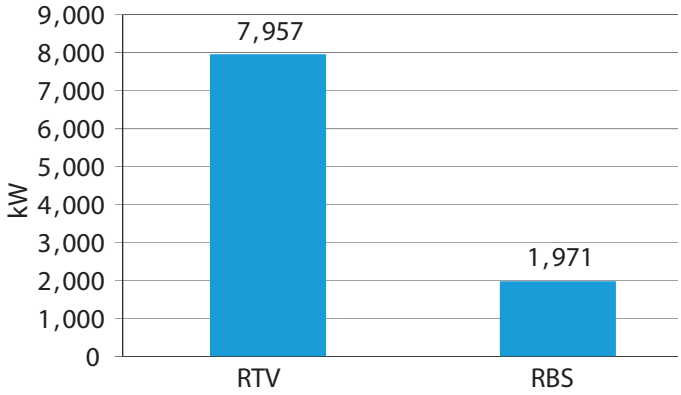
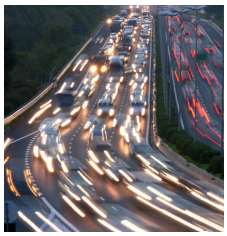


Figure 5.6: Total power, comparison between RTV and RBS for regions for which complete results are available (2007)[6]

In this context, another significant source of pressure is that created by high and extra-high voltage power lines (Figure 5.7). Based on the regions that have provided complete data for the years 2006 and 2007, it can be seen that there has been a 27% increase in the number of 200kV and a 2% increase in the number of 380kV power lines. In contrast, there has been a slight decrease, equivalent to 4%, in the number of low voltage power lines carrying less than 40kV and a slight increase, equivalent to 7%, of those carrying between 40kV and 150kV.
In 2007, medium and low voltage power lines (<40kV) accounted for most of Italy's power grid. The latter represent the final stages of the production, transmission and distribution of electric energy and are therefore present in far greater numbers than power lines carrying higher voltage electricity (the kilometres of power lines carrying >40kW represent only 5% of the total).

[6] Source: ISPRA/ARPA/APPA (EMF Observatory) data processed by ISPRA



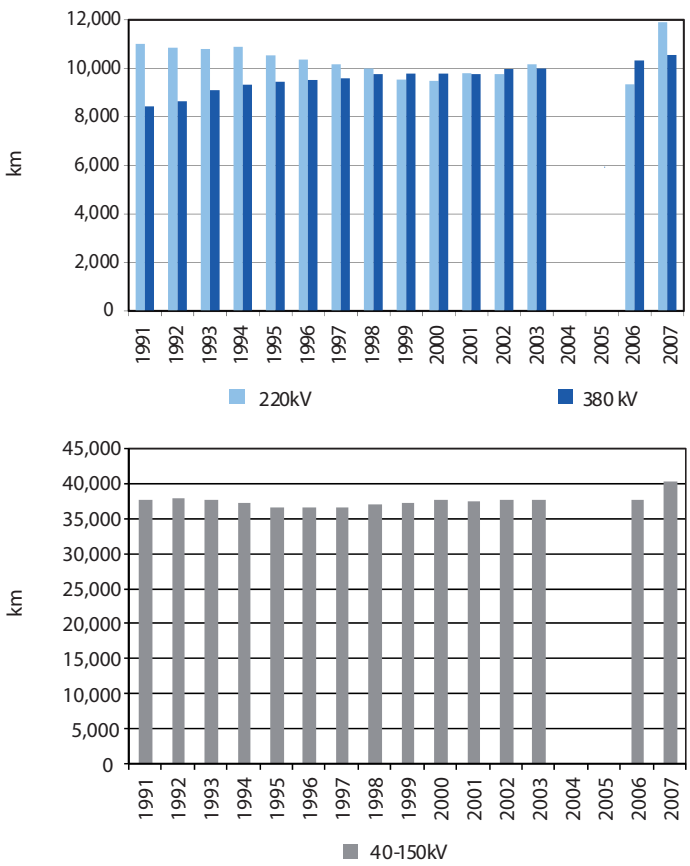
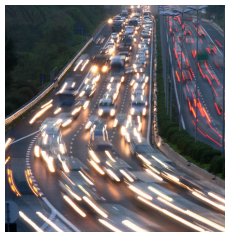


Figure 5.7: Trends in the length of high and extra-high electric power lines in Italy[7]

Between 2006 and 2007, there was the equivalent of a 27% increase in the number of 220 kV power lines and a 2% increase in those of 380 kV. There was also a slight reduction, equivalent to 4%, in the number of power lines under 40kV and a slight increase, equivalent to 7% , of those between 40kV and 150 kV .

It is important to remember that the intensity of electro and magnetic fields is, respectively, proportional to the operating voltage (which is fixed) and the electric current circulating in the conductors (which varies according to customer demand). Gener-

[7] Source: ENEL Terna, ENEL Distribution, DEVAL S.p.A. and the EMF Observatory data processed by ISPRA
Note: The data relates only to those regions that have provided full and complete information.



ally speaking, higher voltage power lines carry a greater amount of electricity and as a result, the electric and magnetic fields generated by medium-low voltage lines are, on the whole, smaller than those created by higher voltage power lines.

Actions to limit electromagnetic pollution

Carrying out controls is fundamental when they reveal that exposure limits have been exceeded.

In terms of both RTV and RBS radio frequencies and extremely low ELF frequencies, control activities are a fundamental part of the operations carried out by the responsible authorities (ARPA/APPA), and in cases where such initiatives reveal violations of exposure limits, safety levels and quality targets, those who manage or own the plants take whatever clean-up action is necessary.

Analysis of the data from the EMF Observatory shows that, between 2006 and 2007, there was a decrease in the number of preliminary assessments regarding the authorization of both RBS and RTV plants of 23% and 14% respectively. As to the number of controls, both experimental and those using models, there was 19% decrease of those relating to RBS and a slight increase, of 42%, for RTV (Figure 5.8).

Between 2006 and 2007, a reduction in the number of preliminary assessments is evident for both RBS (-23%) and RTV plants (-14%), along with a reduction (-19%) in the number of checks carried out on RBS plants and a notable increase (+42%) of those regarding RTV plants.

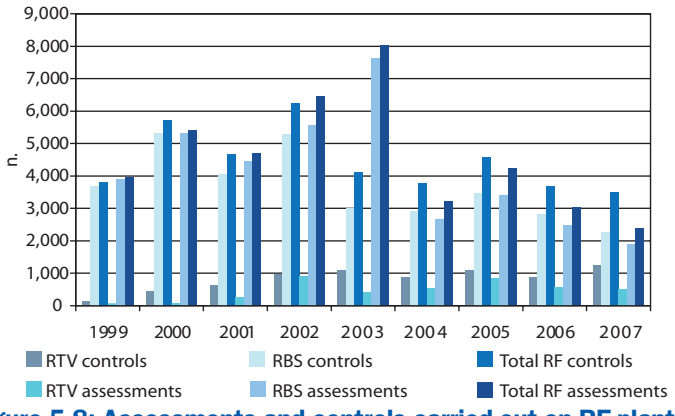
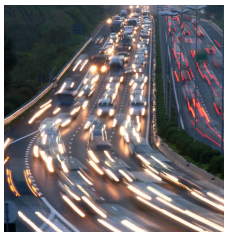


Figure 5.8: Assessments and controls carried out on RF plants in Italy, broken down by source type[8]

[8] Source: ISPRA, ARPA/APPA (EMF Observatory) data processed by ISPRA
Note: The data relates only to those regions/autonomous provinces that have provided full and complete information.



As to the number of assessments and controls regarding ELF (extremely low frequency) power lines, Figure 5.9 shows that there was a significant increase, between 2006 and 2007, in the number of assessments and the number of controls effected (both in terms of measures taken and models based on calculations), equivalent to 10.6% and 21.2% respectively.

The number of assessments carried out between 2006 and 2007 increased by 10.6% whilst the number of checks carried out increased by 21.2%.

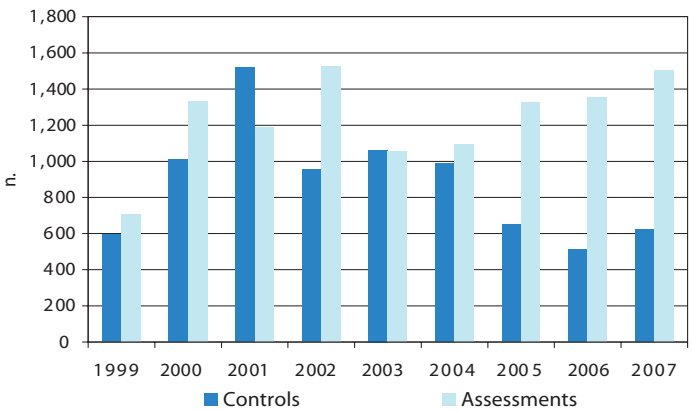
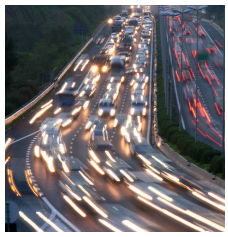


Figure 5.9: Trends in the number of assessments and controls of sources of ELF fields in Italy[9]

In terms of the clean-up initiatives undertaken to date regarding violations identified through control activities, what stands out is that from 2006 to 2007, in those regions that have all the data pertaining to those two years, there was a 7% increase in the number of RTV plants and a 25% increase in RBS plants. It is interesting to note (Figure 5.10) the differences between the two types of sources, RTV and RBS, with regard to the clean-up activities that have been completed and those still underway: for RBS plants, the difference between the percentage of completed clean-up activities and those underway is greater than that relating to RTV plants. This is due to the fact that, in the case of the RTV plants, clean-up activities are technically more complex, generally involve more plants and it frequently proves impossible to

Fewer interventions were completed on RTV plants than on their RBS counterparts because the clean-up process is that much more complex.

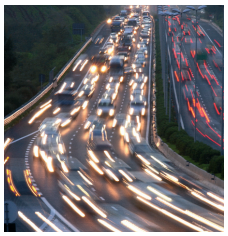
[9] Source: ISPRA, ARPA/APPA (EMF Observatory) data processed by ISPRA
Note: The data relates only to those regions/autonomous provinces that have provided full and complete information.



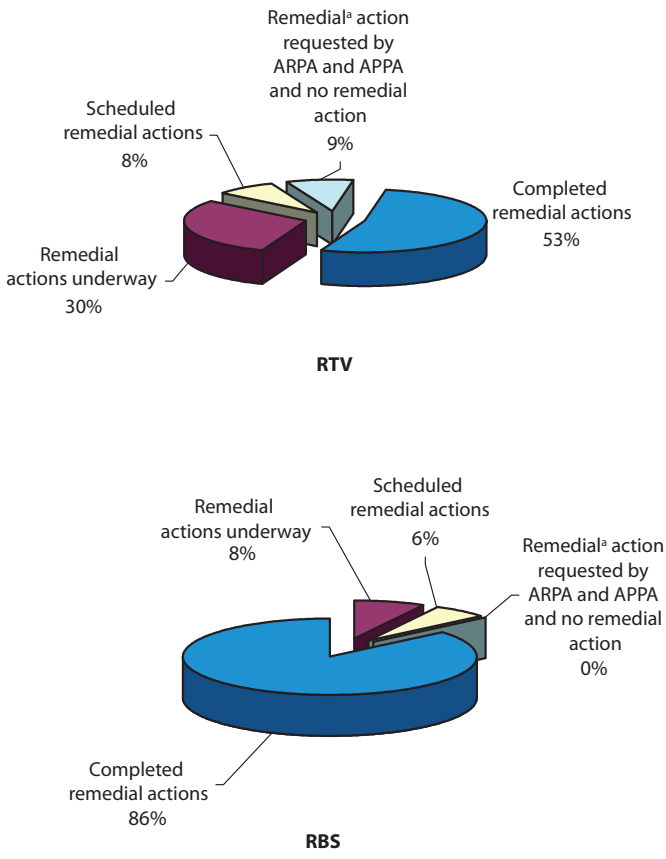
maintain the quality of service set down in the acts of concession. Conversely, in the case of RBS plants, clean-up activities generally take place immediately, are technically less demanding and costs are generally more contained.
Regions for which data relating to 2006 and 2007 is complete, also show that the number of cases of "clean-up efforts requested by regional and provincial agencies to safeguard the environment and no clean-up activities" have been reset at zero as far as RBS plants are concerned and reveal an approximate 8% reduction for RTV plants. This means that there is a marked tendency to deal with situations in which legal limits are exceeded and not to leave them unresolved.
There is, however, no information available regarding clean-up efforts relating to power lines and this is probably due to the lack of a decree of implementation of Law 36/2001 (article 4, paragraph 4) which does, in fact, set out the criteria to be used in formulating such clean-up efforts.

Italian legislation is based on the principle of precaution and in fact takes the possibility of risks related to prolonged exposure into consideration, even when this is at low-levels.

The current Italian legislative scenario pivots around the concept of "prudent avoidance", which underlines the importance of avoiding or reducing exposure to an external agent to the minimum possible should there be any doubts regarding its potential threat to human health. In fact, even in the absence of a confirmed cause-effect connection between exposure to electrical, magnetic and electromagnetic fields and any health consequences, the practice at national level is to consider the potential risk connected to prolonged low-level exposure over time.
At present, 19 regions have regulatory measures in place in compliance with current national legislation. This, combined with a legislative framework that places a special focus on safeguarding the individual and respecting the environment (the correct urban/environmental development of plants and systems, techniques for mitigating the visual impact of the same etc.), means that public awareness remains noticeably high and shows no signs of waning, meaning that social attention to the issue continues to be elevated.



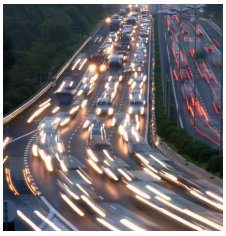
In 2007, the clean-up operations carried out on RBS plants were considerably more than those carried out on RTV plants (53%).



Note: [a] By clean-up action requested, it is those actions requested by ARPA/APPA that is intended, not those programmed by those who own the plants.

Figure 5.10: Status of clean-up activities at sites where a violation of a limit was recorded on account of RTV or RBS plants (2007)[10]

[10] Source: ISPRA, ARPA/APPA (EMF Observatory) data processed by ISPRA
Note: The data relates only to those regions/autonomous provinces that have provided full and complete information.



HIGHLIGHT BOX

Ultraviolet radiation

Ultraviolet radiation takes up the 100 to 400 nanometres (nm) range of the electromagnetic wavelength spectrum. With regard to other wavelengths, UV radiation occurs just beyond (ultra) light that is visible at a shorter wavelength perceived by the human eye to be violet in colour, hence the name "ultraviolet".

UV rays are generally divided into three spectral ranges:

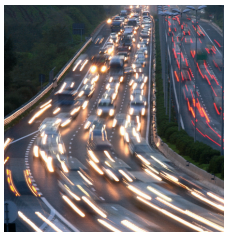
- UV-C 100-280 nm: this form of radiation is completely absorbed by the ozone and oxygen present in the upper layers of the atmosphere. UV-Cs account for 0.5% of the solar energy that affects the outermost layers of the atmosphere.
- UV-B 280-315 nm: this component represents 1.5% of the solar energy that affects the outermost layers of the atmosphere. Stratospheric ozone absorbs more UV-B radiation than anything else. Thanks to the shielding effect of the ozone layer, only 10% of the UV-Bs produced by the sun reach the earth's surface.
- UV-A 315-400 nm: is the range of UV rays least absorbed by the atmosphere. It carries 6.3% of the solar energy that reaches the outer layers of the atmosphere and more than 95% of all the UV rays that reach the earth's surface.

The changes in the middle layers of stratospheric ozone and the ozone "hole" above Antarctica make studying ultraviolet solar radiation and its effects on the environment and human health ever more topical.

The study of UV radiation is carried out within two vastly different parameters:

- the UV-index, which describes the intensity of UV radiation found in shorter wavelengths that have a higher photon energy level (around 280-320 nm) and its capacity to cause skin irritation.
- UV radiation within the UV-A range which produces rays less likely to cause skin irritation but that are overall more active.

The measurements of solar UV radiation taken by the ARPA Aosta Valley are generally expressed as units of the UV index. This number, usually somewhere between 1 and 10, has been chosen as the way in which to raise public awareness of the dangers asso-



ciated with excessive exposure to the sun, according to individual skin type, and the importance of taking adequate protective measures.

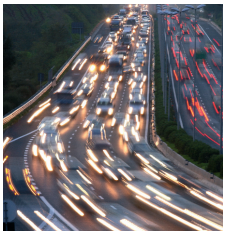
Use of the UV index is recommended by important world-wide organizations such as the World Health Organization (WHO), the United Nations Environment Programme (UNEP) the World Meteorological Organization (WMO) and the International Commission on Non-Ionizing Radiation Protection (ICNIRP).

Exposure to the ultraviolet component of solar radiation has physiological benefits to human health – UV-B radiation is in fact fundamentally important in the endogenous production of Vitamin D3 – and also has a tanning effect that is much sought after for aesthetic reasons. That said, it should also be remembered that a tan is a defensive response by the body when faced with progressive exposure to the sun's rays, which is triggered by knowledge of the harm this causes that is inherent in the DNA contained in skin cells.

Solar radiation as a whole (ultraviolet, visible, infra-red) has been assigned group one classification by the IRAC (International Agency for Research on Cancer), or in other words, not only is it certainly cancerous to man, it is believed that it is its UV component that makes it so.

Monitoring ultraviolet radiation is particularly important in the Aosta Valley given the average altitude of the area (UV radiation increases with height), the noteworthy segment of the population that carries out activities at altitude and because of the presence of snow on the ground for much of the year which, due to its reflective potential (its albedo), effectively increases exposure to ultraviolet radiation. The ARPA Aosta Valley has undertaken a monitoring programme aimed at:

- starting to acquire a series of historic data that can be used to evaluate the medium and long term tendencies of UV solar radiation on the earth's surface as related to variations to stratospheric ozone levels.
- obtaining data that can be used to acquire a better knowledge and understanding of the interaction between the UV component of solar radiation and the atmosphere that will also lead to greater knowledge of the dynamics of photochemical smog.



- evaluating the effect of exposure to solar UV radiation on a large number of people who are for either professional or leisure purposes, involved in activities carried out at altitude.

UV radiation is measured at three locations in the Aosta Valley:
– Saint-Christophe (570 m.a.s.l.- meters above sea level)
– La Thuile - Les Granges (1,640 m.a.s.l.)
– Plateau Rosa (Valtournenche, 3,500 m.a.s.l)

These three locations represent three different environmental situations. Saint-Christophe is located on the valley floor, characterized by its lower height and less frequent occurrences of snow that settles. La Thuile - Les Granges is a typical mountain location and its higher altitude is susceptible to climatic conditions and solar radiation, which is also determined by the more extensive presence of snow throughout the year. It is also not far from the ski-area that is very busy during the winter season. Plateau Rosa, finally, is a typical Alpine glacier area that is subject to extreme climatic conditions and the presence of snow throughout the year.

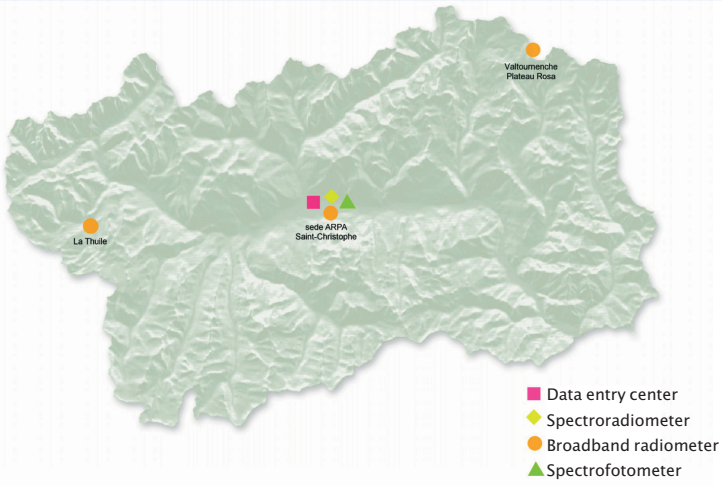
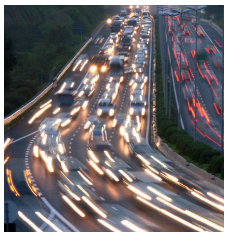


Figure 5.11: The UV radiation monitoring network of ARPA Aosta Valley[11]

[11] Source: ARPA Aosta Valley



The choice of sites in which monitoring is carried out is deliberate, made so that the so-called "altitude effect" - how UV radiation increases along with the height - can be studied as fully as possible. The reason for this effect is that sun rays passing through a thinner atmospheric layer are not absorbed to the same extent, and snow on the ground, which is highly reflective, is able to increase the levels of radiation received.

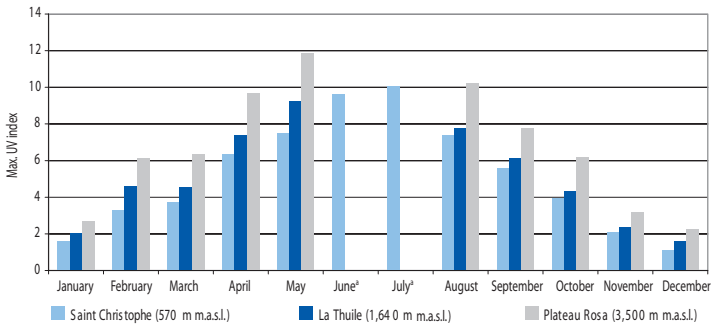


Figure 5.12: UV index, the maximum hourly value by month (2007)[12]

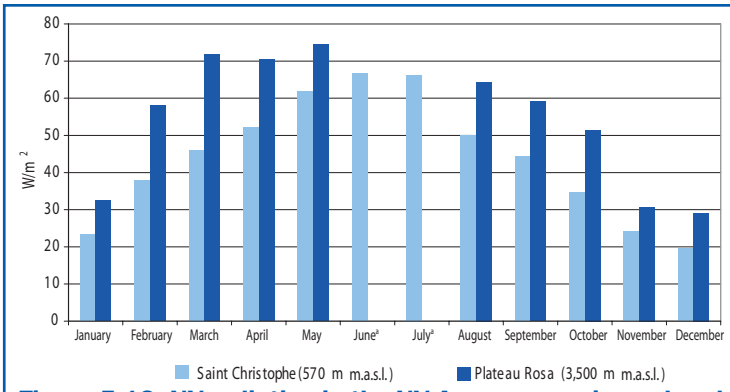
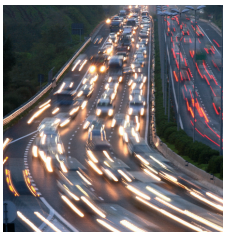


Figure 5.13: UV radiation in the UV-A range, maximum hourly value by month (2007)[13]

[12] Source: ARPA Aosta Valley
[13] Source: ARPA Aosta Valley
[a] Note: Some radiometric values in June and July are being calibrated.



As can be seen, the annual UV index typically registers its lowest levels in Winter and the highest in Summer, in the same way as solar irradiation. Use of mathematical models makes it possible to project the measurements taken locally at the three locations throughout the entire Aosta Valley area. Below is a typical map showing the UV index forecast across the entire Aosta Valley area on a day when the skies are clear.

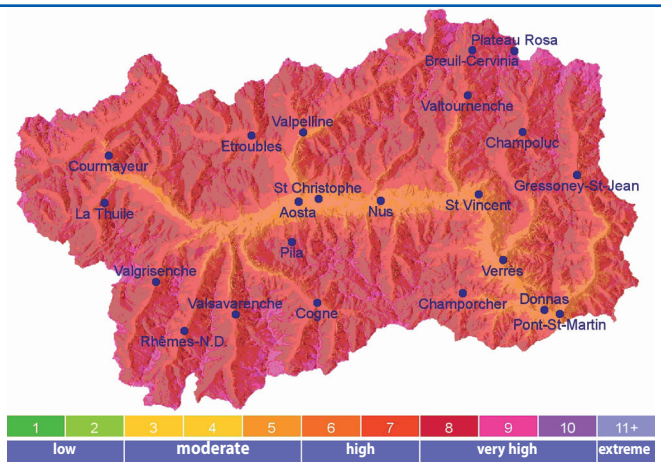
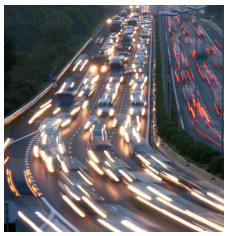


Figure 5.14: Maximum UV index forecast for a clear day in the Aosta Valley - 22/04/2008 (at 12:20 Italian summer time)[14]

The colour scale used for maps of the UV index is that established as standard by the WMO. When clear skies are forecast, the factors listed below are borne in mind as they determine the intensity of UV radiation emitted by the sun that reaches ground level:

- the inclination of the sun in respect of the vertical axis (zenith angle), that varies according to season
- the altimetrical height
- orientation of the slopes
- the amount of sky visible above the outline of the mountains, from all points of view

[14] Source: ARPA Aosta Valley



- the total amount of ozone present in the atmosphere
- the presence of aerosols in the atmosphere
- the ground's reflection coefficient (albedo) based on the presence or absence of snow.

Forecast maps are also produced on the basis of cloud cover, based initially on images received from weather satellites. As one might imagine, cloud cover is an important influence when it comes to determining the effective levels of UV radiation in each location and on a minute by minute basis. The map (Figure 5.15) is an example of one that illustrates actual levels of UV radiation, effectively updating the situation forecast for the identical time frame (same day, same time) shown in Figure 5.14 but which is based on the cloud cover present. Forecast maps are updated daily and disseminated over the ARPA's website Aosta Valley and on a portal dedicated to this topic (www.uv-index.vda.it).

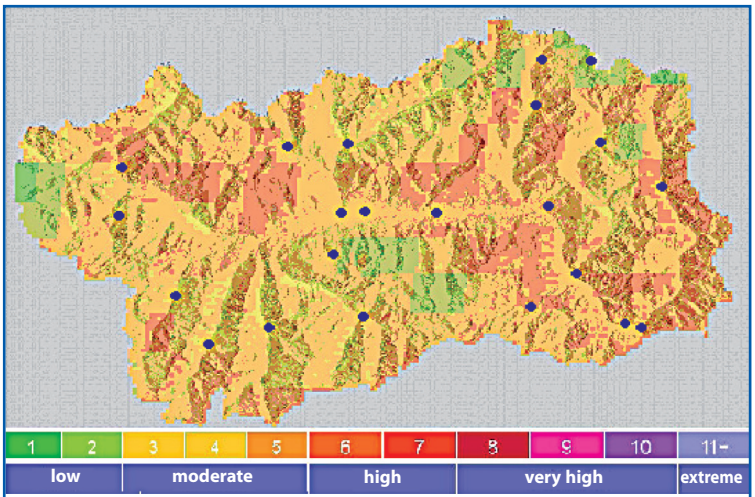
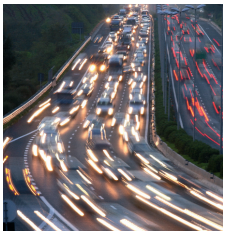


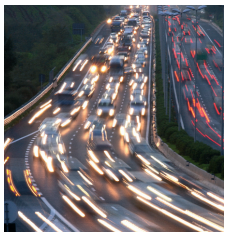
Figure 5.15: Actual UV index in the Aosta Valley, on a cloudy day - 22/04/2008 (at 12:26 Italian summer time)[15]

In addition to the monitoring and forecasting the situation regarding solar UV radiation in the environment, the ARPA Aosta Valley has also, in collaboration with the Physics Department of

[15] Source: ARPA Aosta Valley



the University of Rome “Sapienza”, carried out research into the UV exposure of individuals in a snowy location. This research project, aimed at better determining levels of exposure to solar UV radiation by skiers, was carried out in the La Thuile ski area in April 2006 and February 2007 and involved two groups of volunteers, skiers and ski instructors from the local school.
The research entailed measuring the amount of UV radiation registered by fixed instruments in specific locations (recording environmental levels) and at the same time, the amount to which skiers were exposed (recording individual levels). The instruments (radiometers), in fact, measure the radiation attracted by a fixed, horizontal surface, and by skiers who are constantly on the move and whose bodies are in a vertical position. The levels to which skiers were exposed were evaluated by means of chemical dosimeters fixed to the front part of the skiers hats in a vertical position. The dosimeters themselves were made of a tiny piece (approx. 1 cm^2) of polysolphone film, a material that has the capacity to alter its properties (photodegrade itself) and the greater the exposure, the greater the change. It is characterized by the fact that its sensitivity to change is similar to that of human skin. Skiers used a specially designed chart to record the length of time the different dosimeters were exposed and the basic details of the weather conditions at the time they were skiing: sunny, overcast or variable sunny/overcast conditions and researchers replaced the dosimeters every 2 hours. The purpose of the research was to determine the relationship between individual and environmental exposure (known as the Exposure Ratio or ER).
The results of this study highlighted the fact that skiers are frequently exposed to greater levels of exposure than their surrounding environment.
Although the average Exposure Ratio recorded was 60% in February and 102% in April, maximum levels as high as 172% were also recorded. When skiing in fact, one is exposed to UV radiation emitted directly by the sun as well as that reflected off the snow. The conclusions drawn by the research will make it possible to update some of the tables used by the World Health Organization that currently show test measurements of Exposure Ratios that are decidedly



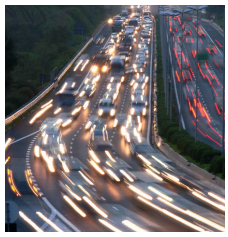
lower (under 30%), and to introduce appropriate preventative programmes that promote safe exposure to the sun. Analysis has also determined the limitations of the current definition of the UV index as a guide to personal levels of UV exposure.

Another important variable of UV radiation is column ozone, that is to say the ozone contained within a vertical band of the atmosphere that extends from the earth's surface to the apex of the atmosphere itself. Ozone, together with oxygen, is one of the most significant absorbents of ultraviolet rays: every decrease in the amount of ozone in the atmosphere causes an increase in the amount of UV radiation that reaches ground level and consequently also increases the risk to human health.

Between heights of 15 and 50 km in the stratosphere, the ozone produced by UV rays acts as a shield against the actual UV rays themselves and is therefore of benefit to and a safeguard for the eco-system.

Stratospheric ozone accounts for 90% of column ozone, whilst the remaining 10% concerns tropospheric ozone, which is generated in the lower layers of the atmosphere by the reaction of solar rays to pollutants. The amount of column ozone varies according to the season but that variability is not symmetrical in both hemispheres, as the highest levels of ozone are to be found at higher latitudes and in winter and spring. Furthermore, the greatest amount of ozone is produced in the tropical stratosphere but is considerably less around higher latitudes and in the lower stratosphere. Meteorological phenomena also effect the variability of column ozone – a few days of low or high pressure conditions can make a noticeable difference in the measurements of ozone levels taken. The primary concern when measuring column ozone levels is the rate at which the atmosphere absorbs ultraviolet radiation emitted by the sun. The path this takes as it intersects the atmosphere passes through different heights, latitudes and longitudes before it touches the ground.

The ARPA Aosta Valley is part of a worldwide network that monitors ozone levels (www.woudc.org), and creates mathematical models so that a global map of the situation can be drawn up. There are currently two test sites in Italy that supply the worldwide network with figures, one is that used by the ARPA Aosta Valley whilst the University of Rome "Sapienza" mans the other.



The diagram that follows shows average daily column ozone levels measured in Dobson Units[16] by the Saint-Christophe test station. The two blue arrows show the minimum and maximum levels (at the bottom and top of the chart respectively) recorded there.

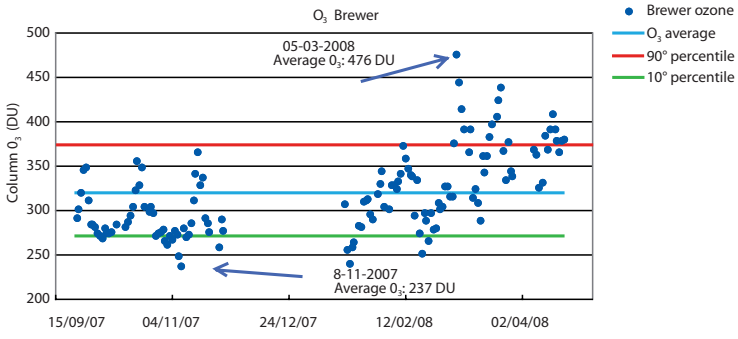
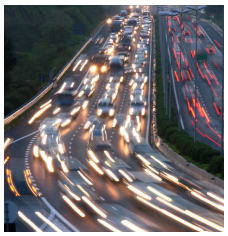


Figure 5.16: Average daily levels of column ozone recorded at the Saint-Christophe test station [17]

With a view to involving all regions in the positive outcome already experienced by the Aosta Valley and establishing, in the short term, a national network that monitors UV radiation, all regional agencies have accepted the proposal put forward by the Institute for Environmental Protection and Research (ISPRA) to set up a working group which is in fact, being co-ordinated from the Aosta Valley.
Details of the activities being carried out by these working groups can be found on a website created for that purpose and are available at www.uv-index.it

[16] A Dobson Unit or DU, named after G.M.B. Dobson (1889-1976), who pioneerd research into stratospheric ozone, expresses the concentration of ozone in a column as the thickness of the layer that all the ozone present in a column would have if it were laid out on the ground to form a layer of pure O_3 at a temperature of 0 °C and at 1 atmosphere of pressure. The thickness of this layer in hundredths of a millimeter (10-5 m) represents the concentration in terms of DU, so if it were 1mm thick it could be described as having 100 DU of O_3.Calculations confiirm that one DU is equal to 2.69×10^{16} ozone molecules in a column that measures 1 cm^2 at its base or a volume of 5×109 m^3 of O_3 (0 °C; 1 atm)
[17] Source: ARPA Aosta Valley



IONISING RADIATION

The problem

To the general public, the term “ionizing radiation” often provokes the fear associated with effects on health, such as burns resulting from extreme exposure similar to those incurred following the explosion of the nuclear bombs over Hiroshima and Nagasaki. These effects are technically defined as “deterministic” and are the result of extreme exposure. Other fears concern the effects of less severe exposure that are not immediately noticeable but that manifest themselves over time or in future generations and they are often associated with the risk of cancer . A clear example of this are the consequences on the exposed population following the accident at the Soviet nuclear reactor in Chernobyl. These effects are technically known as “stochastic”, meaning that the probability of them to occur depends on the intensity and duration of the exposure.

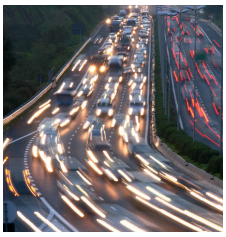
To the general public however, ionizing radiation is nearly always only associated with the production of nuclear energy, including the treatment and disposal of the radioactive waste it generates. The fear this incurs is often caused by a preconceived idea that totally fails to take into account the costs and benefits associated with this form of energy when compared to other technological means of energy production.

Even so, there are cases when exposure to ionizing radiation is generally accepted, such as for medical, diagnostic or therapeutic purposes. In such cases, any resulting risks are perceived to be more than outweighed by the benefits that those undergoing such treatments experience.

“Justification” is one of the fundamental principles adopted in safeguarding the general public and the workforce from radiation. Any activity that subjects either the general public or the workforce to exposure, must in fact be justifiable once costs and benefits have been weighed up and other alternatives have been considered. Moreover, the level of exposure must be “optimized”, so that it is as low as possible.

A second consideration regards the entity of any exposure to sources generated by anything other than those described above.

Ionising radiation is almost always only associated with the production of nuclear energy although in fact, exposure to ionizing radiation is also a medical, diagnostic or therapeutic procedure. In such instances, the risks involved are considered to be more than outweighed by the benefits incurred by those that undergo such treatments.



In fact, if atomic bombs and nuclear incidents are excluded, then any exposure that results from activities associated with energy production is by far inferior to any that results from natural sources. Both in the cosmos and in the earth is crust, and even in our own body, there are sources of ionizing radiation responsible for an exposure thousands of times greater than the nuclear industry.

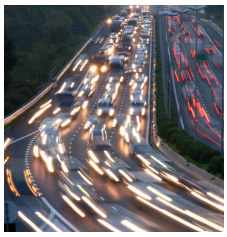
The main source of exposure to ionizing radiation occurs in a domestic setting and in other indoor situations, which is where people spend most of their time. In fact there is a natural gas present in the air in all these locations, called radon, which is one of the main risk factors that everyone has to face. Moreover, in some cases, it reaches such high levels of concentration that on the cost – benefit scale mentioned above, the associated risks are considered unacceptable and taking action to restore healthy conditions to the living environment is highly recommended or even obligatory.

These considerations make the need to find out more and increase awareness of exposure to ionizing radiation, so that the assessment of the risks and benefits associated with all sources of radiation becomes easier and is better understood.

These considerations make the need to find out more and increase awareness of exposure to sources of ionizing radiation clear. In this way, the assessment of the risks and benefits associated with all sources of radiation will become less difficult and better understood.

Radon exposure

The situation with regard to radon exposure was made clear in the results of a nationwide investigation carried out in the 80s and 90s, which is still valid for the characteristics of the phenomenon (Figure 5.17).



High concentrations of radon (Rn-222) have been noted in Lazio and Lombardy. The two regions differ from the others mainly because of their uranium content and the different permeability of their rock and soil beds.

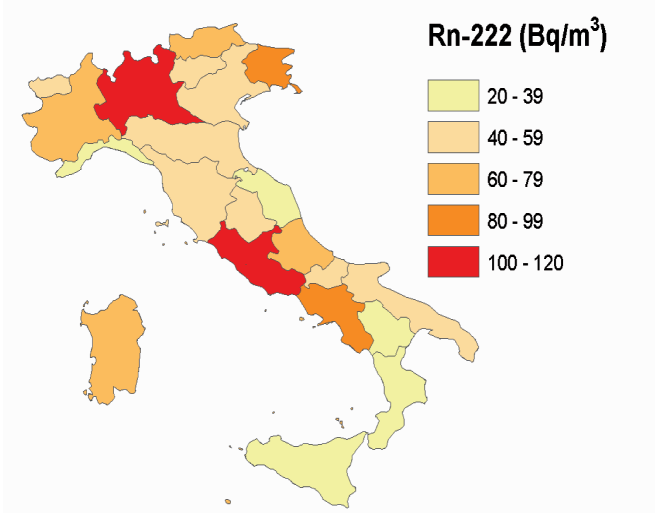
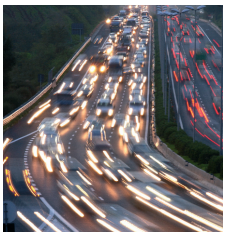


Figure 5.17: Map showing the concentration of Rn-222 present in homes by region and autonomous province (the choice of scale used is of purely exemplary value) (1989-1997)[18]

As a consequence of this investigation, the problem of protecting the workplace from radon exposure was legally addressed with Legislative Decree n. 241/2000, which implements the Council Directive 96/29/Euratom and modifies and integrates the earlier Decree n. 230/1995. The decree sets out the obligations of both employers and the regions. In particular, the latter are charged with identifying the "prone areas" meaning areas with higher probability of high indoor radon concentrations. Pending the determination of the criteria to be used to identify these areas and the methods to be adopted in that process, some regions and some ARPA/APPA have started studies and investigations that will permit classification areas according to the likelihood of high concentrations of indoor radon. The regions, in which such studies have been started are shown in Figure 5.18.

[18] Source: F. Bochicchio, et al., *Results of the national survey on radon indoors in the all the 21 Italian region, Proceedings of Radon in the Living Environmental* Workshop, Athens, April 1999



Pending the determination of the criteria to be used to identify the areas with high concentrations of radon and the methods to be adopted in that process, some regions and some ARPA/APPA have started studies and investigations that will make it possible to classify areas according to the likelihood of high concentrations of radon being present.

Figure 5.18: The regions (in green) where studies/initiatives aimed to identify radon prone areas have been underway since 2002 [19]

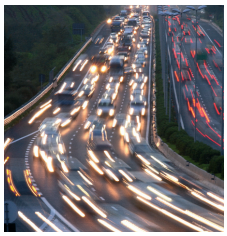
In conclusion, information on the remedial action carried out in Italy in places where there is a high concentration of radon is still scarce for both domestic situations and workplaces.

Surveillance of environmental radioactivity in Italy

In Italy, controlling levels of radioactivity is organized at three levels: local, regional and national.

The surveillance of environmental radioactivity in Italy is organized according to Italian law, under Legislative Decree 230/95 and its subsequent modifications, as well as European legislation, through a combination of networks that operate at three distinct levels: local, regional and national.
Local networks are in charge of surveillance on nuclear plants, regional networks are in charge of monitoring the level of radioac-

[19] Source: ISPRA, ARPA/APPA



tivity in the environment in their respective territories, whilst national networks provide an overall picture of the situation in Italy and are responsible for raising the alarm in the event of widespread contamination.
The diagrams below show the trend of Cesium-137 concentration in airborne particulate over a period of years, as well as in wet and dry deposition and in cow's milk (Figures 5.19, 5.20 and 5.21).

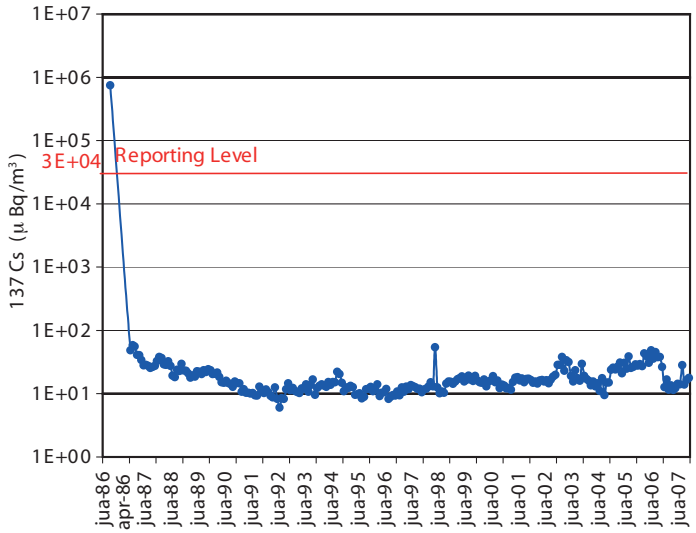
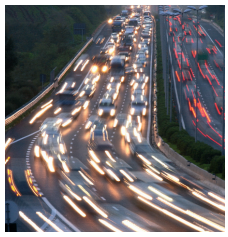


Figure 5.19: Trend of Cs-137 concentrate in airborne particulate in Italy[20]

The diagram shows the contamination peaks associated with the arrival in Italy of the "Chernobyl cloud" (April 1986) and of the fall-out that resulted from an incident in a Spanish foundry in Algeciras (June 1998) which was much more noticeable in northern Italy. Levels recorded in recent years have remained stationary and well below the reporting level established by the EU (30 μBq/m³).

[20] Source: ISPRA/ARPA/APPA data processed by ISPRA's environmental radiation laboratory service, OECD-ENEA, 1987, *The Radiological impact the Chernobyl accident in OECD countries*, Paris - ISPRA



This diagram highlights the level of Cs-137 in the fallout associated with tests carried out in the atmosphere in the 50s and 60s as well as the peak that resulted from the Chernobyl accident in 1986. Since then, there has been a steady reduction in contamination levels of dry and wet deposition.

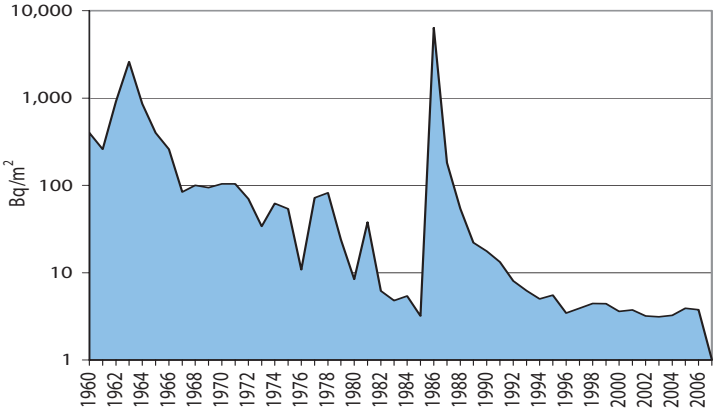


Figure 5.20: Trend of wet and dry deposition of Cs-137 in Italy[21]

This diagram reveals ever-decreasing levels of contamination in cow's milk that is today, approximately two orders of magnitude less than it was in 1987, the year after the fallout from Chernobyl. Since 1990 Cs-137 contamination levels have been below the reporting level established by the EU (0,5 Bq/l).

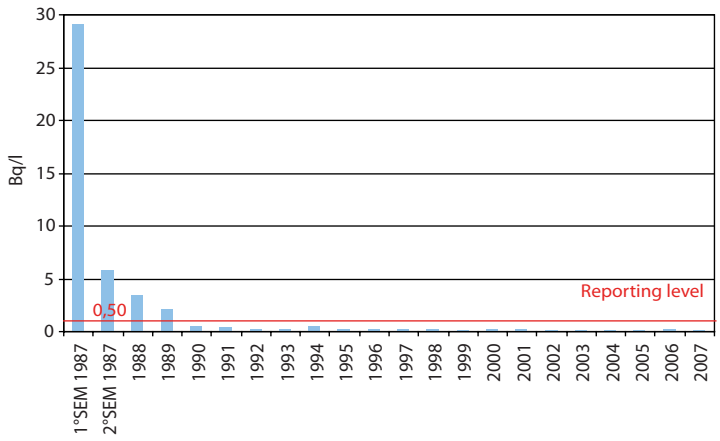
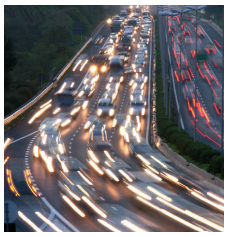


Figure 5.21: *Trend* showing the concentration of Cs-137 in cow's milk in Italy [22]

[21] Source: ISPRA/ARPA/APPA data processed by ISPRA's environmental radiation laboratory service, OECD-ENEA, 1987, *The Radiological impact the Chernobyl accident in OECD countries*, Paris - ISPRA

[22] *Source:* ISPRA/ARPA/APPA data processed by ISPRA's environmental radiation laboratory service, OECD-ENEA, 1987, *The Radiological impact the Chernobyl accident in OECD countries,* Paris - ISPRA



In terms of response, the situation in Italy can be represented by the level of implementation of the network monitoring programme.
Table 5.1 shows the scores given during the evaluation of nationwide monitoring carried out from 1997 onwards that is based on methodology elaborated for the ECOEHIS (Development of Environment and Health Indicators for EU countries) project.
Annual scores are attributed on the basis of the following matrices: airborne particulate, ambient gamma dose rate, cow's milk, surface water and drinking water. Each of these matrices was evaluated according to the frequency of the measurements, the sensitivity of the measurements, territorial coverage of controls, regularity of monitoring, the organization of and participation in interconfrontation initiatives on a nationwide basis.

Table 5.1: Evaluation of the state of monitoring carried out over national networks[23]

Year	Ranking	Evaluation
1997	15	satisfactory
1998	17	satisfactory
1999	13	unsatisfactory
2000	17	satisfactory
2001	17	satisfactory
2002	17	satisfactory
2003	17	satisfactory
2004	17	satisfactory
2005	17	satisfactory
2006	17	satisfactory
2007	17	satisfactory

Legend: classes of quality : unsatisfactory 0 ≤15 satisfactory 15 ≤21 good 21-25

Analysis of the monitoring programme highlighted that coverage of the entire national territory was incomplete and that corrective measures must therefore be taken.

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[23] Source: ISPRA/ARPA Emilia Romagna data processed by ISPRA