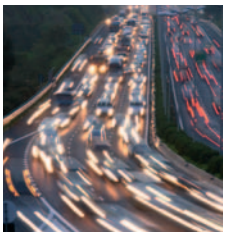
CHAPTER 5

EXPOSURE TO PHYSICAL AGENTS

NOISE
NON-IONISING RADIATION
ULTRAVIOLET RADIATION
IONISING RADIATION



Introduction

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The term "Physical Agents" describes those environmental pollutants which, governed by the laws of physics, bring about a change of the environmental conditions of the context in which they are present. Their presence, in living and working environments determine how much energy, potentially detrimental to human health, is emitted. Physical Agents that effect the environment are electromagnetic fields, the levels of noise in a residential setting and in daily life, ionising radiation, vibrations, light pollution and ultraviolet (UV) radiation.

Noise pollution is characterized by how widespread it is and the high 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.

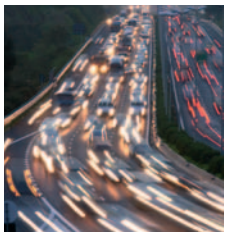
Noise pollution is considered one of the most significant causes in the deterioration of the quality of everyday life and it constitutes one of the most serious environmental problems. It is characterized by how widespread it is and the high impact it has on the environment, eco-systems and the population. 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 in its member states exposed to noise must be a primary objective, achievable by adopting the same methods aimed at minimising the phenomenon. The detailed legislation on this subject and the existence of preventative and clean-up measures has to date, failed to resolve this environmental issue and it remains a priority.

There continues to be greater social concern about the dangerous effects that electromagnetic pollution has on human health.

There continues to be considerable social concern about electromagnetic pollution because of the dangerous effects it has on human health, even if at national level, the risk connected with prolonged exposure is considered 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 aspect has also resulted in specific regulations clearly aimed at safeguarding the individual.

Ionising radiation consists of particles and/or energy of natural or artificial origin pable to modify the structure of the matter with which it interacts.

Ionising radiation consists of particles and/or energy of natural or artificial origin able to modify the structure of the matter with which it interacts. Interaction with biological tissue can cause cell damage with possible morphological and functional changes to affected organs that can cause health problems in those individuals who have been exposed to it. Although, there are no active nuclear plants in Italy, the pressure on the environment



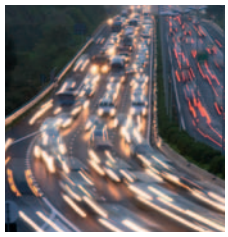
caused by ionising radiation continues to be both relevant and manifold. This includes: the production and necessary treatment of radioactive waste created by diagnostic and/or radiotherapy procedures carried out in hospitals; the growing worldwide production and circulation of radioactive materials; the radiation coming from natural origin materials (NORM and radon) that are, to date, the main source of exposure. Therefore, radiation protection must continue to be the key issue of any environmental safeguards along with the protection of the population and workers. The risks that would derive from any decrease in care and ability to control and to monitor the levels of radioactivity in the environment and in foodstuffs, could inevitably lead to uncontrollable social and economic situations that would arise from insufficient knowledge of the problems caused by exposure to ionising radiation.

Interaction with biological tissue can result in possible cell damage, in the form of morphological or functional alterations to the organs concerned.

Less attention is paid to other agents by members of the public and legislators alike, 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 to certain types of transport infrastructures) and light pollution does not create any easily apparent discomfort to individuals. Ultraviolet (UV) radiation warrants separate consideration, as the health implications are particularly noticeable in terms of the damage excessive exposure to this type of radiation causes to the skin and 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 simply issuing recommendations by means of opportune notices published in the press, what protective measures should be taken and to providing bulletins about UV levels.

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.

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

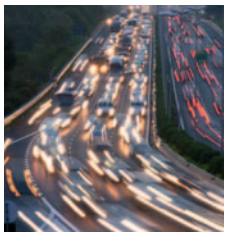
The problem

With regard to noise pollution, considered one of the main environmental problems today, the main objective, at European level, is the progressive reduction of the number of people exposed to noise levels deemed detrimental to people's quality of life or health.

European policy regarding noise pollution, considered one of the most serious environmental problems, has determined that the progressive reduction of the number of people exposed to levels of noise deemed detrimental to the quality of life or, potentially, to the health of local residents, is a matter of priority. The main measures adopted by the European Commission are the creation of a network of experts from all the different of this subject area; to specify what information is to be made available and that it should be accurately produced and supplied in a comparable and uniform manner that supports the political initiatives taken. Equally important are the proclamation of European Directive 2002/49/EU[1] regarding the assessment and management of environmental noise and Directive 2002/49/EC, transposed into Italian legislation with Legislative Decree no. 194/2005[2]. This sets out how to assess environmental noise and asks the pertinent authorities in member States to draw up acoustic strategic maps showing urban agglomeration sand the main vehicular, railway and airport infrastructures using L_{den} and $L_{night,}$ the new indicators introduced to estimate the annoyance levels or the degree of sleep-related problems resulting from noise. Other actions introduced by the directive deal with the adoption, by member states, of Action Plans aimed at reducing environmental noise, especially in those areas where it has proved detrimental to health; safeguarding those areas where the acoustic quality is good, and ensuring that the public is provided with information about environmental noise and its effects, and even, in some circumstances, the involvement of members of the public in the process of drawing up the plan itself.

With regard to informing the public and building a shared data bank that will make it possible to make consistent and compa-

[1] Directive 2002/49/EU, issued by the European Parliament and Council on 25 June 2002, concerns the measurement and management of environmental noise.
[2] Legislative Decree no. 194 of 19 August 2005: «The Implementation of Directive 2002/49/EU regarding the measurement and management of environmental noise» (Legislative Decree published in the Official Gazette – general series – no. 222 of 23 September 2005)

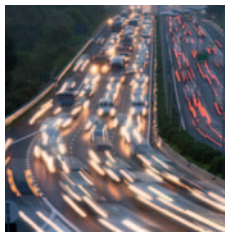


rable readings of the situations that exist in member states. Since October 2009, it has been possible to consult the NOISE[3] (*Noise Observation and Information Service for Europe)*, database that holds information obtained through the implementation of actions envisaged in the directive. Since 1996, the year in which the *Green Paper on Future Noise Policy*[4], the first document to define European policy regarding noise pollution was published, standard, shared information that addresses the issue of noise pollution has been available within Europe. An initial analysis of the data that constitutes an organic and complex information system shows that there is a significant percentage of the population exposed to noise levels high enough to be bothersome or disturbing although levels vary between the different member States and in relation to the diverse sources of noise. According to the data collected in February 2009, around 41 million people living in Europe's urban agglomeration are exposed to L_{den} values exceeding 55 dB(A) caused by the noise from roadway infrastructures.

Analysing the total number of people living outside the urban agglomerations of the European Community, in buildings exposed to a noise source, namely road traffic, that produces L_{den} values above 65 dB(A), it can be seen (Figure 5.1) that in comparison to other member countries, a large percentage of the population of Italy is exposed. The situation is worse still if one considers that the total number of people, living in the same circumstances as those described above, exposed to L_{den} levels above 75 dB (A) (a decidedly high level) is greater than 80,000. This represents a group of people living with the highest levels of noise registered anywhere in countries that are part of the European Community. (Figure 5.2). In addition to the critical aspects already presented, a complete and even more in-depth study of the data just published may show, in due course, the actual connotations and dynamic principals that the subject acquires at both national and community levels.

It has been shown that around 41 million people in the European Community in urban agglomeration are exposed to environmental noise at Lden levels that exceed 55dB (A) caused by roadway infrastructures.

[3] http://noise.eionet.europa.eu/index.html
[4] Future Noise Policy. European Commission Green Paper. Brussels, 04/11/1996



Analysing the total number of people living outside the urban agglomeration of the European Community, in buildings exposed to a noise source, namely road traffic, that produces L_{den} values above 65 dB(A), it can be seen that in comparison to other member countries, a large percentage of the population of Italy is exposed.

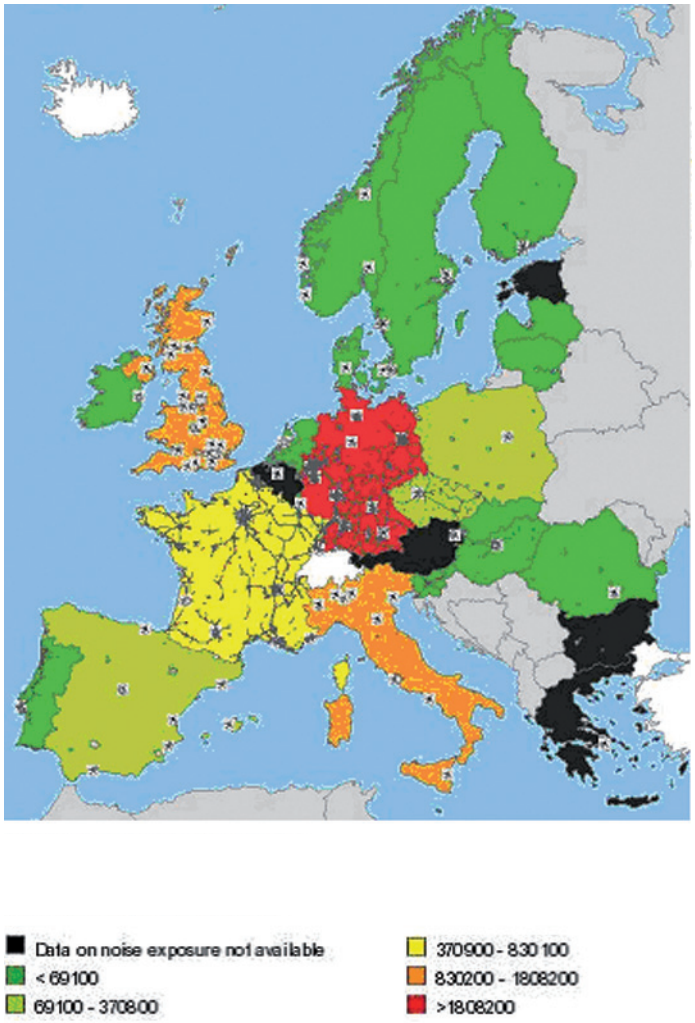


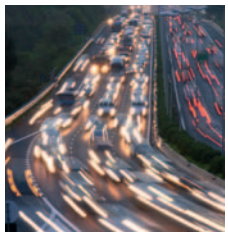
Figure 5.1: The total number of people living outside the urban agglomeration of the European Community in buildings exposed to a noise source, namely traffic on major roads, that produces L_{den} values above 65 dB(A) (2009)[5]

[5] Source: NOISE, Noise Observation and Information Service for Europe

Analysing the total number of people living outside the urban agglomeration of the European Community, in buildings exposed to a noise source, namely major road traffic, that results in L_{den} values above 75 dB(A), the situation in Italy is actually even worse. The number of people exposed to these higher levels, greater than those recorded in other countries is more than 80,000.

Figure 5.2: The total number of people in the European Community who live outside the urban agglomeration in buildings exposed to a noise source, namely major road traffic, that results in L_{den} levels > 75 dB(A) (2009)[6]

[6] Source: NOISE, Noise Observation and Information Service for Europe



In many cases, the targets set out in Legislative Decree 194/2005 issued in compliance with END Directive 2002/49 EC have not been met by the deadlines established.

The conditions set out in Legislative Decree 194/2005 in answer to Directive END 2002/49/EC concern: urban agglomeration with more than 250 thousand residents; roadway infrastructures that carry more than 6 million vehicles per year; rail infrastructures with more than 60 thousand convoys per year and major airports handling more than 50 thousand flights per year. To date however, the targets have not, in many cases been met by the deadlines established. In particular, of the ten urban agglomeration concerned, only three have presented a strategic acoustic map and none has drawn up an Action Plan. As far as the airports are concerned, of the nine major airports involved, six have presented a strategic chart and four, an Action Plan. There has been greater compliance by the vehicular infrastructures, with twelve out of the thirteen of the pertinent roadway networks – those carrying more than six million vehicles per year – presenting an acoustic map whilst of the four railway infrastructures carrying more than 60 thousand convoys per year, only one has presented an acoustic map. (Table 5.1)

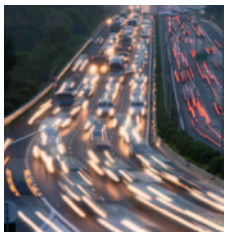
Of the ten urban agglomeration concerned, three have presented a strategic acoustic map but none has drawn up an Action Plan. The situation regarding the roadway infrastructures however is better, as 12 of the 13 concerned have presented an acoustic map.

Table 5.1: The State of Affair regarding compliance with the actions envisaged in the first phase of Legislative Decree 194/2005[7]

Competent authorities	Compliance with Legisltive Decree 194/2005		
	Notifications effected	Acoustic Maps/ Strategic Acoustic Maps	Action Plans
	no.		
Agglomeration	10	3	0
Roadways	13	12	16
Railways	4	1	2
Airports	9	6	4

Despite of, and taking into account the differing methods used and disparate periods of time concerned, studies carried out on the residents in some of Italy's urban areas have made it possible to extrapolate the percentage of the population exposed to L_{den} values greater than 65 dB (A) and L_{night} values greater than 55 dB (A) as a result of noise produced, in almost all cases, by vehicular traffic. These percent-

[7] Source: Data available from the Ministry of the Environment, Land and Sea responsible for safeguarding the territory and the surrounding seas



ages amount to 24% of the population as far as L_{den} values greater than 65 dB(A) are concerned and 27% for L_{night} values greater than 55 dB(A). Analysis of the work of the network of environmental Regional Agencies throughout 2008 shows that 3,645 controls were carried out and that there are distinct differences in the percentages incurred in the various sectors. The highest percentages, namely 43.2%, represent service and / or commercial activities, followed by productive activities with 28% and roadway infrastructures with 22.9% (Figure 5.3). The percentages regarding service and / or commercial activities and of productive activities, respectively showed a 48.2% and 35.4% decrease in comparison with the previous year, and by 35.4%, whilst roadway infrastructures were subjected to a greater number of controls than the 9.7% recorded the year before.

74% of all controls undertaken were in response to complaints made by members of the public. Of these, the vast majority revealed dissatisfaction with regard to service and productive activities, building sites and short-term demonstrations (94%) whilst a much lower number concerned transport infrastructures (15%). The greater number of complaints made, and the number of cases that recorded excess levels (51%), reveal that the public has a consistent interest in noise pollution, and that faced with what are effectively critical conditions, they would like greater safeguards to be in place.

The public takes great interest in this subject and both personal and environmental safeguards are the key areas of concern. They are responsible for 74 out of 100 complaints made, of which 51% of controls reveals that the limits imposed are being exceeded.

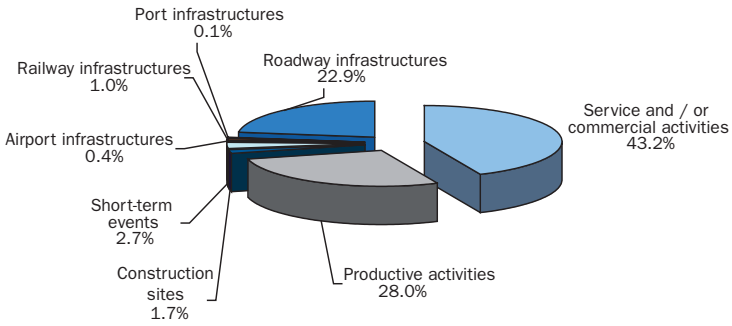
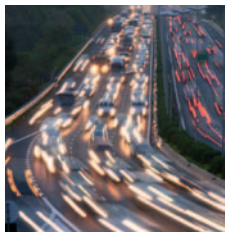


Figure 5.3: Distribution of the sources controlled (3,645) amongst the different types of activities/infrastructures (2008)[8]

The noise sources subject to controls and that the public considers to be extremely bothersome, are commercial and service activities (43.2%), productive activities (28,0%) and roadway infrastructures (22.9%).

[8] 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



The main sources of noise

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

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 linked to individual sources.
Despite showing a percentage decrease of -4.3% last year, an overall increase of 11.8% between 2004 and 2008 is, none-the-less evident, whilst data pertaining to airport traffic in particular showed an overall increase of approximately 60% between 1990 and 2008.
As far as passenger rail traffic is concerned, 315 million trains-km travelled on the State Railway system in 2007 (up 5.6% on 2004), whilst rail freight accounted for 63 million trains-km (down 1.2% on 2004).
The requirement for those bodies responsible for running transport infrastructures to draft plans about the actions to take to contain and abate noise as set out in the Ministerial Decree of 29th November 2000 does not yet appear to have been carried out by all the companies concerned. That said, many of them have published the studies that they carried out during the course of the previous year.

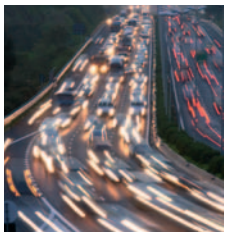
Shortcomings in the legislation and the lack of dialogue between the principal players create an obstacle to an organic definition of the action to take.

The increase in the above-mentioned pressure factors, combined with the shortcomings in the legislation and 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.
Vehicle traffic represents the main source of urban noise pollution, although other sources that should not be ignored include industrial and small-scale production activities, commercial activities with all their related plants and systems (air conditioning, refrigerators etc.) and discotheques, which have a notable impact on their immediate surroundings.

Actions to limit noise pollution

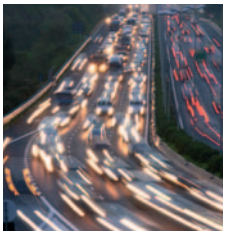
The manner and methods used to bring uniformity to Community and national legislation need to be identified and shared across all the different sectors in this field.

The progressive implementation of the END Directive, albeit with noticeable differences between member countries, shows that at both Community and national levels there is a greater knowledge about the state of the environment in terms of noise pollution, and a greater sharing of the problems encountered and actions undertaken. The need to implement the directive by means of the regulations set out in Legislative Decree 194/2005, and the quest to harmonize Community legislation with the complex national legislative system that has Framework Law no. 447/95 on noise pollution at its heart, are the

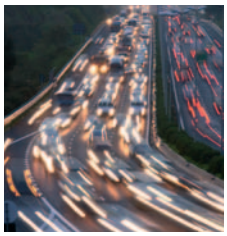


aspects that attract the greatest activity, providing opportunities reconsider the regulations and to develop them further.
Law no. 88 enacted on 7th July 2009, entitled *Dispositions enabling Italy to fulfil its obligations as a member of the European Community – Community Law,* had precisely that need in mind when it introduced, at article 11, the "*Delegation of power to the Government to reorder the regulations regarding noise pollution".* Its purpose is to guarantee that the dispositions set out in the END Directive and laws dealing with this subject are fully integrated. The government was charged that within six months of the law coming into force, it was to issue one or more legislative decrees that would address the *"reordering and reform of the prevailing regulations regarding the safeguarding of the outdoor environment and residential situations against noise pollution, the noise-control measures to be incorporated in buildings and the measurement and management of environmental noise"*[9]. The harmonization of Community and national laws, the determination the criteria to be adopted for the design, building and reconstruction of buildings and transport infrastructures are considered to be a matter of priority as is the determination of the passive acoustic requirements of buildings. Some of the main criticisms made include: the absence of an organic treatment of legislation in this sector and the fact that the decrees set out in the Framework Law regarding implementation have not been completely implemented (the one regarding the establishing of the design criteria to be adopted in new buildings in particular). The failure to comply with the decree dealing with the criteria applicable to the passive acoustics of buildings is another, the classification of which will be covered in when UNI (Ente Nazionale Italiano di Unificazione - Italian Organization for Standardization) present new regulations along with revisions to the texts cited above.
Other critical aspects persist: the fragmented efforts made to prevent and mitigate the effects of noise pollution continue, and in this context, discussions on the nature and finality of the Action Plan introduced by the END directive could play a decisive role.
Although some signs of change are evident, especially with regard to construction, there are still inconsistencies between the different sectors. There are those, such as transport infrastructures, that generate considerable activity, whilst others attract fare less attention,

[9] Law no. 88 enacted 7 July 2009



as for example, in the ambit of territorial and acoustical planning and communications and education on environmental issues and the extent to which members of the public participate in the process.
There are still obvious 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 and are heedful of the demands of the general public both in terms of controls carried out and information provided. Analysis of the data in order to determine whether procedures prescribed by the laws governing the various sectors had been implemented, shows that in respect of previous years, up until to 30th September 2009, the situation at regional and local levels with regard to fulfilling their various obligations was stagnant, but within the ambit of transport infrastructures some obligations had been discharged. 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. According to available data, there are six regions that have not yet passed such regional laws: Molise, Campania, Basilicata, 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 plan or the procedures for certifying an acoustic technician, and these circumvent the lack of a systematic approach at regional level.
Approval of an acoustic classification plan of the territory at local levels is a priority in terms of acoustic planning, as it defines the how the territory is used and it allows the consequent initiatives to safeguard and abate noise in critical areas. By 30th September 2009, some 41% of Italian municipalities had produced a classification compared with the 35% of 2007. There are notable different in the diverse regional situations, with higher percentages of those in the Centre North of the country (94% in Marche, 91% in Tuscany, 85% in Liguria and 71% in Piedmont) whilst the Southern and peninsular regions did far less (Sicily 1%, Sardinia 3%, whilst Molise and Basilicata did nothing at all). 48% of the population live in municipalities that have approved a zoning plan, compared with 46.4 in 2007, whilst at national level, the territorial surface now encompassed plans approved by local councils has



reached 35% compared with 32% in 2007. (Figures 5.4, 5.5, 5.6). The increased number of municipalities that have approved an acoustic classification plan is the reason that slight increases are evident in the regions, and there are a high percentage of municipalities that have already adopted a plan. This highlights the gap that exists between those areas willing to zone practically their entire respective territories, and those that cannot boast a single municipality that has produced an approved zoning plan. The percentage of Italian municipalities now classified has reached 41%, but the huge territorial differences show that the tool has not been adopted in sufficient numbers and that its use is not consistent at national levels, with only a few regions having effective policies whilst others are characterized by their inertia. Critical issues regard the public's lack of knowledge about the plan, its relative incidence throughout the country, and the state of the environment. This is due to insufficient information being provided and the excessively sectorial nature of acoustic planning which has not yet been incorporated into the principal regulations governing territorial planning or any other related plans of an environmental nature.

Acoustic classifications plan of the territory are not applied in sufficient numbers throughout Italy and nor are they evenly distributed. In some regions, policies have been seen to work, whilst other regions can be characterised by their inertia.

As of 30 September 2009, the equivalent of 41% of all Italy's municipalities had approved acoustical classifications plans: Marche (94%), Tuscany (91%), Liguria (85%), Piedmont (71%).

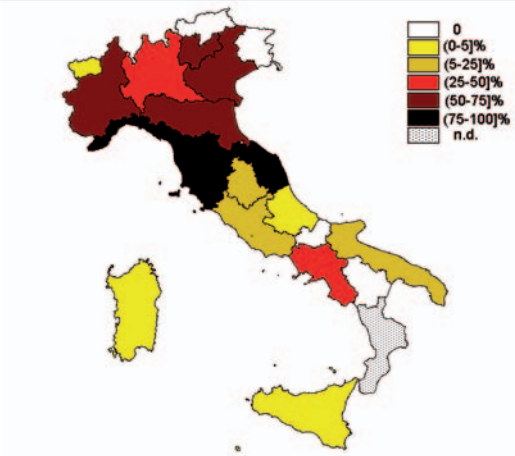
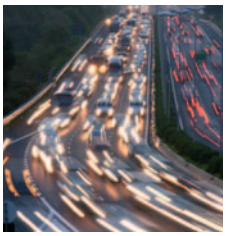


Figure 5.4: Percentage of municipalities that have approved acoustical classifications plans of the territory out of the total number of municipalities for each region/autonomous province (30/09/2009)[10]

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



The percentage of the population resident in municipalities that have approved zoning plans is now 48%.

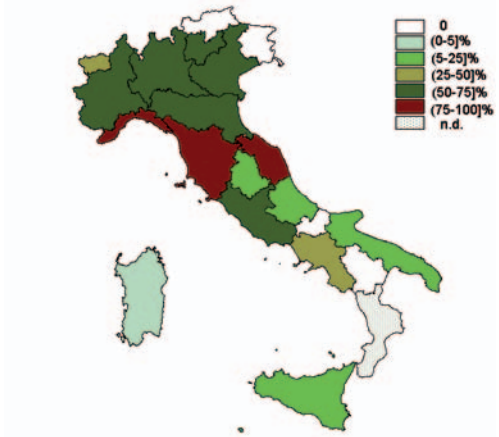


Figure 5.5: Percentage of the population residing in municipalities with an approved acoustical classification plan of the territory, out of the total population of each region/autonomous province (30/09/2009)[11]

In 2009, the percentage of the territorial surface area of municipalities that approved classifications was 35%, compared with the 32% in 2007.

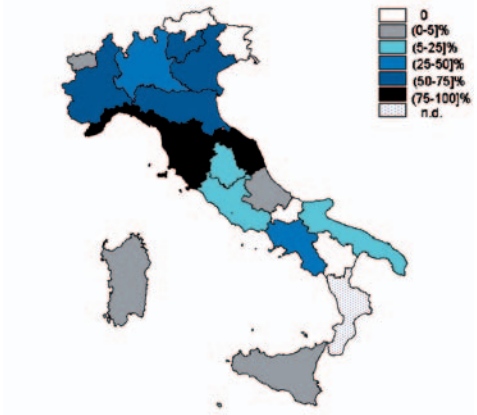
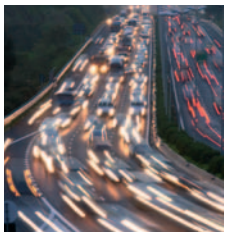


Figure 5.6: Percentage of the territorial surface area of the municipalities that have approved acoustical classifications plans out of the total surface area of the municipalities in each region/autonomous province (30/09/2009)[12]

[11] Source: ARPA/APPA data processed by ISPRA
[12] Source: ARPA/APPA data processed by ISPRA



The obligation to draw up a report on the acoustical status of municipalities at two-year intervals, established by Law 447/95, takes the shape of a document used to analyse and manage the problem of noise pollution at municipal level. Out of a total of 149 municipalities with populations of more than 50,000 inhabitants, that are therefore required to draw up a report, as of 2009 only 22 (15%) had approved a report on their acoustical status. The greatest number of approved reports came from Tuscany where 11 out of 13 municipalities were compliant and in Lombardy, where there were 5 out of 15. Implementation of a municipal acoustical Noise Abatement Plan, as called for under Law 447/95, is not widespread and there are only 51 municipal clean-up plans approved. This represents only 1.5% of the 3,304 municipalities that have approved a municipal acoustic plan, most of which can be found in two regions, Tuscany, that has 38 and Emilia Romagna that has 5.

To consider what municipalities have achieved, 41% have approved an acoustic classification plan of their territory, 1.5% have adopted a noise abatement plan and of those required to produce a biennial report regarding noise levels, a mere 15% have done so.

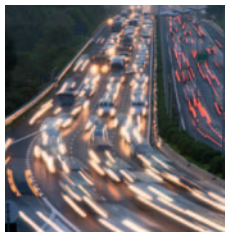
The acoustical classification plan of the areas surrounding airports, called for under Law 447/95 on the subject of airport noise, was carried out by only 12 of the 40 main national airports, whilst they are still being elaborated/evaluated in a further 14 airports.

At present, only 12 out of 40 airports have an approved acoustical classification plan, the main tool used in planning for airport noise.

There are distinctions in the noise abatement initiatives that managers/owners of transportation infrastructures are required to take under the Framework Law. In the case of railways and most 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.

As far as those who manage motorway infrastructures on a concessional basis implementing plans and carrying out initiatives aimed at containing and reducing noise in accordance with DM 29/11/2000, 18 have submitted their plans (PCAR) to MATTM and the regions/municipalities concerned. 3 have failed to present their respective PCARs, declaring that there is no need for any new initiatives along the stretches of motorway they each have in concessions, as they already comply with prevailing regulations, and only one operator has yet to prepare the PCAR regarding the stretch of motorway for which it is responsible. (Table 5.2)

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



Of the total kilometres of motorways operated by concessions, 94.2% have, in accordance with DM 29/11/2000 been analysed within the ambit of a PCAR. A further 3.9% are still outstanding, whilst according to declarations made by the pertinent operators, 1.9% do not require any action to be taken.

Table 5.2: Presentation of Plans by those operating motorway concessions, detailing initiatives aimed at containing and reducing noise in accordance with DM 29/11/2000[13]

PCAR	km	%
Presented	5,230.30	94.2
Yet to be presented	218.00	3.9
Declared unnecessary by the operator	106.60	1.9
TOTAL	**5,554.90**	**100**

It would seem that in this current phase, concentrating efforts on the harmonisation and co-existence of methods and instruments to prevent and mitigate noise pollution is what is required, using the opportunities provided by the legislation that addresses reorganizational issues and incorporates other critical aspects that have persisted for far too long. This legislation also strengthens awareness of the internal dynamics of the country and within the ambit of the European Community.
The instruments used in the prevention, planning and noise abatement processes contained within national laws and those introduced by European Directive 2002/49/EC, must be made more effective and incisive. They must also be accompanied by the provision of correct, clear and comprehensive information on the subject to the public - and the effects of noise pollution on man and the environment in particular.

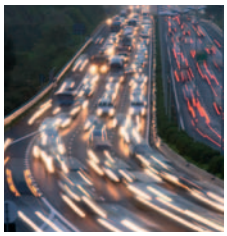
NON-IONISING RADIATION

The problem

The prolonged exposure to electromagnetic fields is believed to be potentially dangerous to human health.

Interest in electromagnetic fields has grown significantly and in line with the frenzied development of new telecommunication systems whose installations have spread across urban areas in a capillary manner, raising doubts and concerns about how dangerous they might be. The intensification of the electricity transmission network resulting from the increased demand for electric energy, as well as the urbanization of areas previously un-

[13] Source: ISPRA

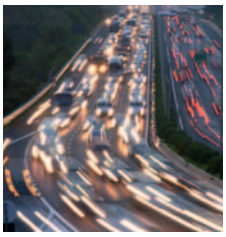


inhabited, characterized by the presence of long distance power lines or radio/television antenna, have also contributed to confusion about the possible effects on health when living close to such installations for an extended period of time.
This predicament, made worse by the public perception that 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. Local government administrators are 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.

Main sources of EMF

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, cell phones, radar).
In terms of radio and television plants (RTV) and radio base stations (RBS), the environmental impact, meaning electromagnetic emissions evaluated according to violations of the limits permitted by the prevailing legislation, shows, respectively, a decrease of approximately 1% and a 7% increase between 2007 and 2008. These percentages were calculated, for those regions that supplied complete data, by analysing data from the EMF (Electromagnetic Fields) Observatory.
Analysis of the data regarding the density of RTV and RBS plants (Figure 5.7) shows that the density of the RBS plants is roughly double that of RTV plants (respectively 0.23 and 0.11 plants per km^2), whilst the density of RBS sites (0.14 sites per km^2) is around 5 times higher than RTV sites (0.03 sites per km^2).

Between 2007 and 2008 there was a recorded decrease in the violations of limits by RTV plants, and an increase of those incurred by RBS plants.



It can be seen that the RBS plants have a approximately twice density than RTV plants. There is a similar situation regarding the density of sites, in effect the density of RBS sites is five times higher than the RTV sites.

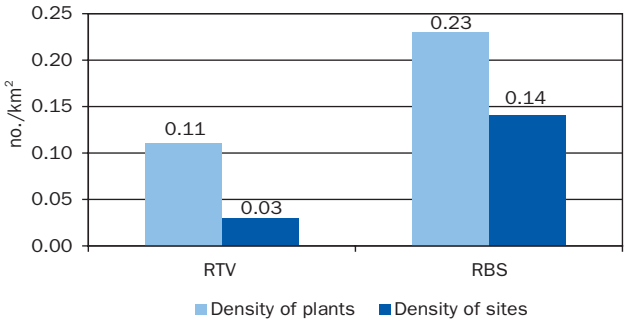


Figure 5.7: Density of plants and sites, a comparison of RTV and RBS for the regions for which complete data are available (2008)[14]

In terms of the overall power of RTV and RBS plants (Figure 5.8), clearly, the most significant environmental pressure produced by electromagnetic fields is generated by radio and television plants. The total RBS power (1,175 kW) in fact, is only around 18% of that generated by RTV plants (6,442 kW). The overall lower power levels associated with RBS plants in comparison 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 just over 5 times more powerful than their RBS counterparts.

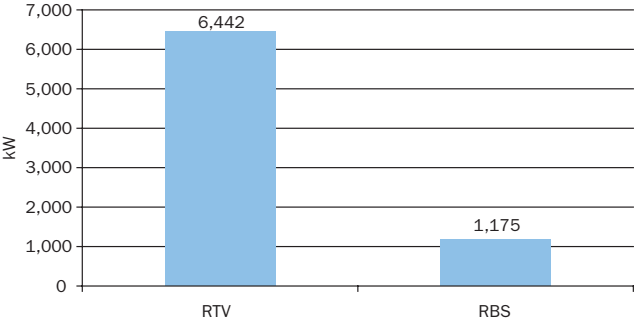
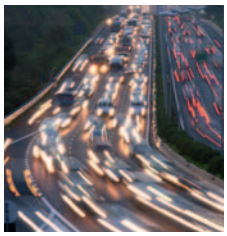


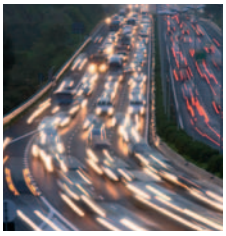
Figure 5.8: Total power, comparison between RTV and RBS for regions for which complete data are available (2008)[15]

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



In this context, another significant source of pressure is that created by high and extra-high voltage power lines (Figure 5.9). Based on the regions that have provided complete data for the years 2007 and 2008, it can be seen that there has been a 15% decrease in the kilometres number of 200 kV power lines and 4% in those between 40 kV and 150 kV (4%) whilst there has been a slight increase (2%) in those carrying 380 kV. In 2008, medium and low voltage power lines (< 40 kV) 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 > 40 kW represent only 5% of the total).

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). 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, in general, smaller than those created by higher voltage power lines.



Between 2007 and 2008, there was a 15% decrease in the kilometres number of 220 kV power lines, of 4% in those between 40 kV and 150 kV, and of 2% in those under 40kV. There was however, a slight increase, equivalent to 2%, in the kilometres number of 380 kV power lines.

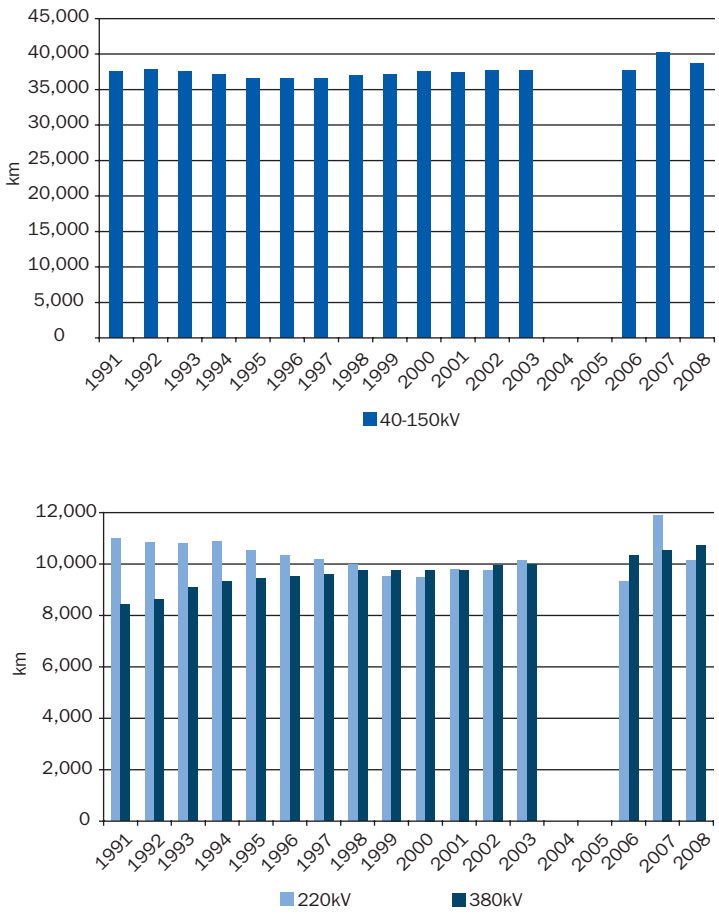
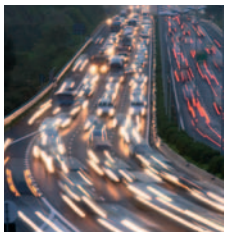


Figure 5.9: Trends in the length of high and extra-high electric power lines in Italy[16]

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



Carrying out controls is fundamental to the work of ARPA and APPA, which reveals if exposure limits have been exceeded.

Actions to limit electromagnetic pollution

In terms of both radio frequencies (RTV and RBS) 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 data gathered by the EMF Observatory shows that, between 2007 and 2008, there was a further decrease in the number of preliminary technical assessments regarding the authorization of both RBS and RTV plants of 17% and 2% respectively. As to the number of controls, both experimental and those using predictive models, there was a decrease of 1% for those relating to RBS and a decrease of 4% for RTV (Figure 5.10).

Between 2007 and 2008, there is a decrease in the number of preventive advice for both RBS (17%) for both RTV (2%), and also a decrease in the number of controls for the RBS (1%) and for RTV (4%).

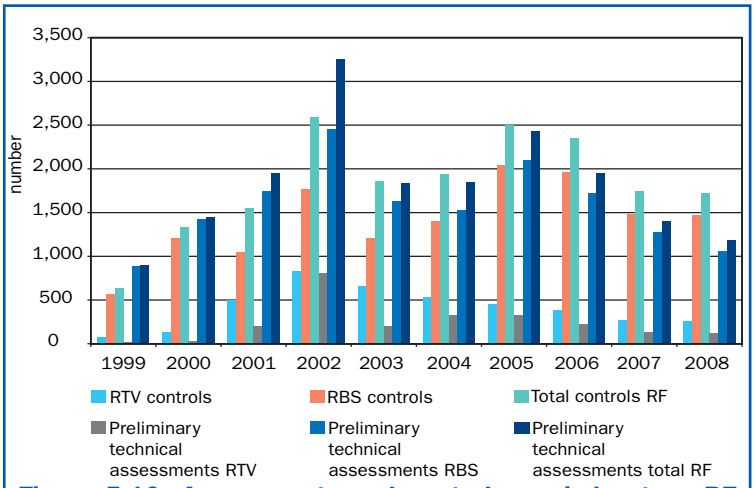
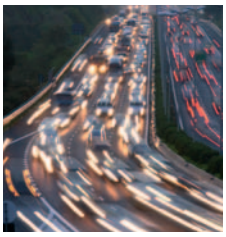


Figure 5.10: Assessments and controls carried out on RF plants in Italy, broken down by source type[17]

As to the number of preliminary technical assessments and controls regarding ELF (extremely low frequency) power lines, it can be seen,

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



from Figure 5.11 that there was a slight reduction in the number of preliminary technical assessments and the number of controls effected (both in terms of measures taken and models based on calculations), equivalent to 1.4% and 1.8% respectively.

The number of assessments carried out between 2007 and 2008 decreased by 1.4% whilst the number of checks carried out decreased by 1.8%.

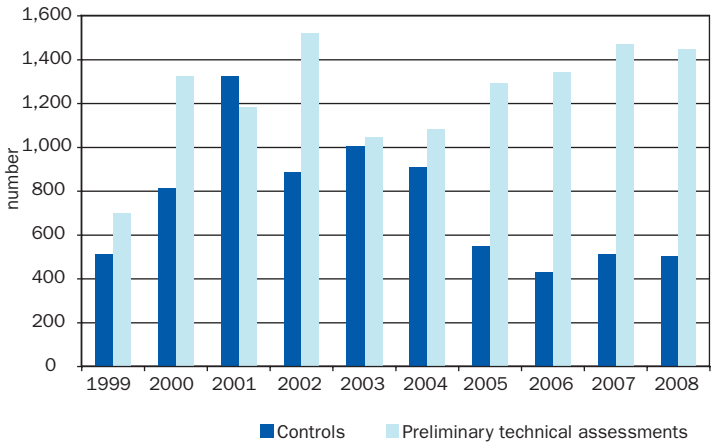
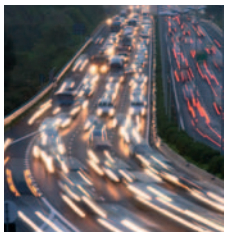


Figure 5.11: Trends in the number of preliminary technical assessments and controls of sources of ELF fields in Italy [18]

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

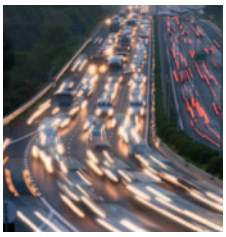
In terms of the clean-up initiatives undertaken to date regarding violations identified through control activities, what stands out is that from 2007 to 2008, in those regions that have all the data pertaining to those two years, there was a 1.3% increase as far as RTV plants were concerned and a 3.4% increase in RBS plants. It is interesting to note (Figure 5.12) 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, not only is the difference between the percentage of completed clean-up activities and those underway greater than that relating to RTV plants, but there are no longer any clean-up operations underway. This difference is due to the fact that, in the case of the RTV plants, clean-up activities are technically more

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

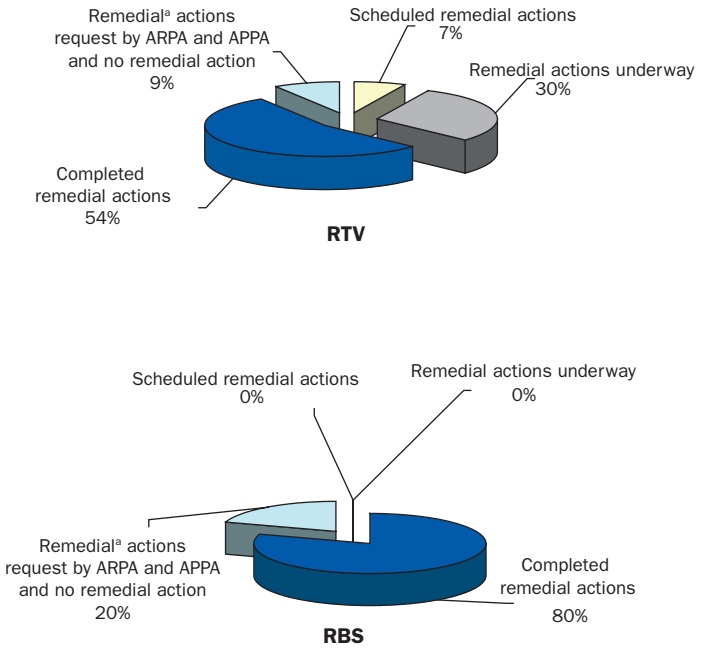


complex, generally involve more plants and it frequently proves impossible to maintain the quality of service set down in the acts of concession. Conversely, in the case of RBS plants, clean-up activities generally take place immediately, are technically less demanding and costs are generally more contained.
The records of regions that have provided a complete set of data for both 2007 and 2008, 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*", has been reset at zero as far as RBS plants are concerned, and reveal an approximate 10% increase for RTV plants. This means that these clean-up operations have not yet been scheduled by plant owners.
There is no information however about any clean-up operations involving electric power lines, and this is probably because there is no decree contained within Law 36/2001 (articles 4, c.4) that sets out the criteria for drawing up such clean-up plans.
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.

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.



In 2008, the number of completed clean-up operations (80%) carried out on RBS plants was considerably higher than those carried out on RTV plants (54%).



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 5.12: Status of clean-up activities at sites where a violation of a limit was recorded because of RTV or RBS plants (2008)[19]

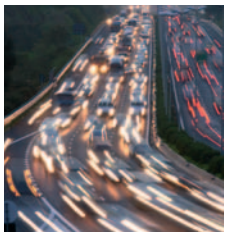
ULTRAVIOLET RADIATION

Introduction

Ultraviolet radiation is that which takes up the 100 to 400 nm (nanometers) range of the electromagnetic wavelength spectrum. Ultraviolet radiation is of particular importance as it interacts with Earth, especially with the stratosphere (the "hole" in the ozone

Photochemical pollution occurs on days characterized by stable weather conditions and strong sunlight. These conditions facilitate photochemical reactions produced by ultra-violet light and the formation of ozone and other substances.

[19] Source: ARPA/APPA/APPA (the NIR -near infra-red- Observatory) data processed by ISPRA
NB: The data related only to those regions / autonomous provinces about which all figures are available



Photochemical smog is composed of substances that are toxic to man, animals and vegetation. Due to their powerful oxidising nature, these substances are also able to cause many different materials to degrade.

layer), the troposphere (photochemical pollution) and ultimately, with the biosphere (the effects on man, flora and fauna). This type of radiation can be produced by sources that can be either natural or artificial: the sun is the most important natural source, whilst a mercury steam lamp (Wood's lamp or germicidal lamp) is an example of an artificial source.

In recent years, many organizations, such as the WHO (World Health Organization), ICNIRP (International Commission for Non-Ionising Radiation Protection) and IARC (International Agency for Research on Cancer) have turned their attention to the risks that result from lengthy exposure to UV rays whether from a natural or an artificial source.

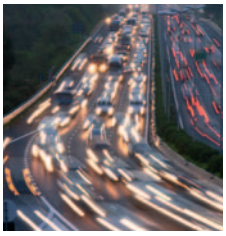
This, together with the fact that the main source of UV rays to which the world's population is exposed and which cannot in fact, be avoided, is the sun, has made it necessary to intensify efforts to provide greater information about the problem. The fields particularly concerned with this issue are:

- environmental and health research to accurately monitor UV rays from the sun and their effects over time, and to increase knowledge of the mechanisms that regulate the interaction between the absorption of UV rays and the appearance of any health problems;
- the spread of information, to make people more aware of the risks they face, often as a result of bad habits or an inappropriate life-style.

The classification of UV radiation

Around the higher wavelengths of the electromagnetic spectrum, UV radiation occurs just beyond light that is visible at a shorter wavelength perceived by the human eye to be violet in colour, hence the name "ultraviolet". At the lower limit, under 100 nm, it adjoins the area of ionising radiation. Ultraviolet radiation is generally classified as follows:

- UV-C 100-280 nm: it is the component with the most energy although it is completely absorbed by the oxygen and ozone present in the upper layers of the atmosphere. UV-Cs account for 0.5% of extra-terrestrial solar energy.
- UV-B 280-315 nm: the stratospheric ozone is the most absorbent gas of this component. It represents 1.5% of all solar energy. Thanks



to the "filtering" effect of the ozone layer, the rays that reach the earth's surface are usually of a wavelength above 290 nm.

- UV-A 315-400 nm: 80% of all UV rays are found in this range, which carries 6.3% of extraterrestrial solar energy.

For the purposes of this document, only UV rays from natural sources will be considered, or in other words, UV radiation originating from the sun.

From the description of each type of UV radiation, it follows that gases such as ozone and oxygen absorb the most damaging rays. In particular, every reduction of ozone in the atmosphere incurs an increase in the number of UV rays that reach the Earth's surface and with them, greater risks for the environment and human health. There are many factors that affect the intensity of the UV radiation that reaches the Earth's surface, but the most significant effect, which shows a direct correlation between the two phenomena, is brought about by the distribution of ozone through the atmosphere (column

The vertical profile of ozone and its effect on those components that are absorbed at lower wavelengths more than others.

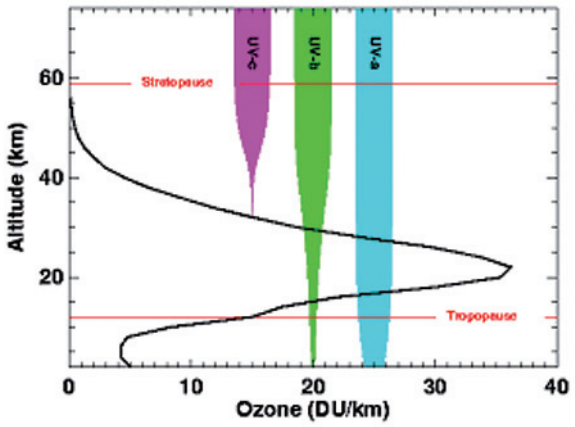
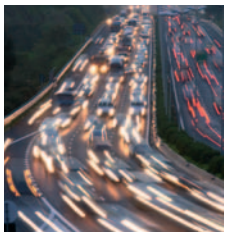


Figure 5.13: The vertical profile of ozone and a qualitative visualization of the mitigating effects of the various components of UV rays before they reach ground level[20]

[20] Source: ARPA Aosta Valley



ozone). The Figure 5.13 shows the vertical profile of ozone and its effect on the three UV bands. It explains the important role played by ozone in modulating UV rays at ground level. Theoretic studies and observations indicate, furthermore, that a 1% reduction in column ozone can cause around a 1.2% increase in the UV rays that cause biological damage at ground level.

Exposure to UV radiation: connected risks and UV index

Exposure to solar radiation is an inevitable occurrence that has both beneficial and detrimental effects on man. It cannot be denied that to expose oneself to the sun generally produces an initial sensation of well-being known as *psychological well-being*. The positive effects do not stop there. The first in-depth studies about exposure to the sun, and in particular to UV rays, were carried out as part of the fight against rickets. UV rays in fact, play a fundamental role in the production of Vitamin D3, which is responsible for the synthesis of calcium in the human body. On the other hand, countering the positive effects of a prolonged exposure to the sun, which is usually what happens if someone is trying to acquire suntan, certain negative effects have also been verified, including some that are of a serious nature. The parts of the human body most sensitive to exposure to UV rays are the skin and the eyes.

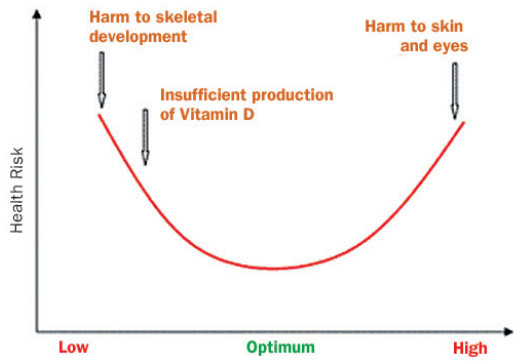
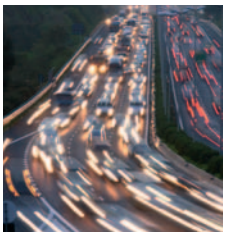


Figure 5.14: Potential health risks linked to exposure to UV rays UV[21]

There is an optimum period of exposure that maximises the positive effects and minimises the negative effect, but this period is not the same for everyone.

[21] Source: ARPA Emilia Romagna



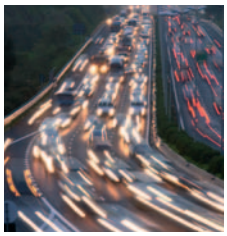
Damage to eyes (photo-kerato-conjunctivitis) has also been proven, and studies are underway to determine whether exposure to the sun also weakens the immune system.

The cause and effect relationship between excessive exposure to solar radiation and skin problems like redness, photo-dermatitis, aging and even cancer is now clear. The UV component and UVB in particular, is one of the major causes of these problems. Damage to eyes (photo-kerato-conjunctivitis) has also been proven and studies are underway to verify whether excessive exposure also weakens the immune system. The Figure 5.14 shows the subjective relationship between the consequences and the length of exposure. It can be noticed that there is an optimum period of exposure that maximises the positive effects and minimises the negative. It should be pointed out however, that this optimum period of exposure is not the same for everyone.
In fact, light-skinned people tan and get sunburned far more easily that those with a dark skin. Information regarding ideal exposure time must, in fact, always keep skin type in mind and be modified accordingly. There is a skin photo type (SPT) classification that shows how skin reacts to ultraviolet radiation in accordance with a person's physical characteristics (colour of hair, eyes and skin) and an individual's capacity to acclimatise – or not – to the sun. Six photo types can be identified:

People do not have an intrinsic photo type, as the degree of skin trauma due to repeated exposure to the sun is also a factor.

I People with very pale skin, red or blonde hair and pale coloured eyes who never tan and always burn;
II Children up to the age of one who have pale skin and eyes as well as blonde hair who they occasionally tan and usually burn;
III People with moderately dark skin, blonde-light brown hair and brown eyes who tan slowly and may burn;
IV People with relatively dark skin, dark brown hair and dark eyes who they tan easily and rarely burn;
V People with dark olive coloured skin, dark hair and eyes who burn and acquire a deep tan;
VI People with black hair, eyes and skin who quickly acquire a deep tan.

Most Italians are classified as types III and IV.
Each photo type can be characterised by a minimum level of erythema (skin irritation), which establishes the amount of exposure necessary to incur the minimum visible sign of irritation. This depends on factors such as wavelength, the intrinsic sensitivity of the exposed skin and previous periods of exposure.
The qualitative definitions described above can be referred back to a quantitive evaluation linked to the lowest level of exposure that irri-

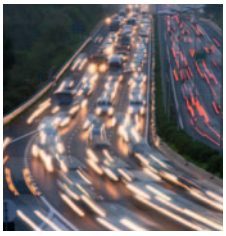


tates the skin. This lowest level is known as the *minimum erythemal dose* (MED). Values are determined by experimenting first on unprotected skin (MED u) and then on skin that has been protected by products such as suntan cream (MED p). A MED is defined as being the actual amount of UV able to cause human skin to visibly redden even if it has not previously been exposed to the sun.

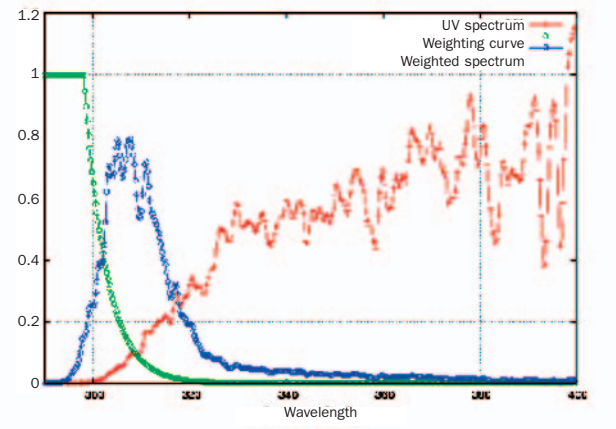
As people's sensitivity to UV radiation is not the same, the MED of different European nationalities varies from between 200 and 500 (J/m^2). Average thresholds are calculated according to the photo type of provenance: 200 for photo type I, 250 for photo type II, 350 for III and 450 for photo type IV. Information is usually based on the MED p, which is related to the protection afforded by suntan cream in which a number that relates to a recommended exposure time describes the protection factor. This information can be misleading unless a dermatologist, following the examination of a particular individual, endorses it. The fact that the phrase "total protection" once used to advertise certain creams is now illegal is not something that happened by chance. There is also a risk that people will be convinced that certain practices are acceptable, whereas in fact they should be modified or discontinued, as they are in fact what incur the biggest risk of all.

As far as UV rays from artificial sources are concerned, reference is made to an article written by the International Agency for Research on Cancer (IRAC) who studied the risk factors of products used by millions of people as they tanned. Published in the Lancet Oncology magazine in 2009, it would be hard to misinterpret the statement *"the use of tanning devices* (beds & lamps*) is carcinogenic to humans"*. The same article also reports that the risk of melanoma, a dangerous form of skin cancer, increases by 75% if the use of such tanning devices starts before 30 years of age.

The degree of damage depends on the biological effect, which is determined by a weighting equation that represents the biological response to UV radiation and the length of exposure. Consequently, it is important to inform any individual who is intent on acquiring a suntan about the potential harm that over-exposure could cause. The Figure 5.15 shows the relationship between UV radiation (the red curve) with the erythemal weighting equation (the green curve) thus showing the radiation level that causes biological damage to the skin (blue curve).



The wavelengths that cause erythema fall within the range of UVA radiation and in part within the UVB range too.
Furthermore, the erythemal weighting curve shows that the epidermis is particular sensitive to low wavelengths. Of these, only those within the UVB range cause harm in that there is no UVC at ground level (cf red curve). This is why UVB is the most dangerous type of radiation even when present in only small amounts. By taking into consideration all contributing factors over a unit of time, it is possible to calculate the level that affects the skin. This value rounded up or down to a whole number, provides the UVI index.

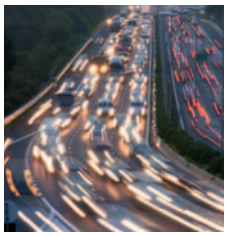


Note: The blue curve represents the composition of the other two; the area that subtends the curve represents the amount of energy that is absorbed by the skin within the unit of time indicated.

Figure 5.15: The state of UV radiation at ground level (red curve) of the erythemal weight (weighting curve in green) and of the radiation that is biologically harmful to skin (blue curve)[22]

This index was developed as part of a collaborative effort between the World Health Organization (WHO), the United Nations Environment Programme (UNEP), World Meteorological Organizations and the International Commission on Non-Ionising Radiation Protection (ICNIRP). The UVI defined as weighted radiation, with an erythemal weight function (the ponderal curve) relative to the 280-400 nm spectral interval divided by 25 mW m^2 only provides information about the possible effects on the skin and does not take individual characteristics into account. Although it does not give any direct information about the possible effects on the eyes, these are taken into consideration in any recommendations made in association with the UV index, as it is also germane to the protection of the eyes.
In addition to this numeric classification, the values in the index are also organized according to the degree of risk incurred, and by associating different colours to the various categories of exposure obtained

[22] Source: Conference transcripts: "Monitoring and forecasting the Ultraviolet Index", Matera 20 June 2008



in this way; the chart produced is immediately understandable. The various categories have also been associated with a series of countermeasures to be adopted as UVI levels increase in order to limit exposure. An easily understood graphic has been devised to describe these precautions, intended to make the message more easily accessible to the public at large. As UVI can be measured or calculated on a second by second basis with mathematical models and irradiation at ground level depends on the time of day, its progression varies over time. The WHO has therefore deemed it necessary to suggest, in order to provide information in a uniform manner, that it should be the maximum daily level that is communicated, calculated as an average over a 30-minute period. If continuous data is available however, the WHO suggests that the average UVI be calculated every 5 or 10 minutes and that this information be used to show its progress over a period of time. The maximum daily UVI level is usually calculated over a four-hour period around solar noon, a time that varies from country to country, according to geographic location and whether or not summer time is adopted, but it is usually between 12 noon and 2 p.m. Furthermore, unless specified otherwise, UVI should be calculated on the basis that the sky will be clear, but whoever is responsible for the forecast may choose to calculate the information when conditions are overcast too.
Standardising the UVI index has provided an immediately understandable tool with which to inform the public about UV radiation. Correct information can only be provided if the UVI value is combined with a person's photo type.
The Figure 5.16 shows an international classification of the UVI index using numbers and colours from the lowest ranges (UVI =1-2, green) through to the highest range (UVI=11, purple).

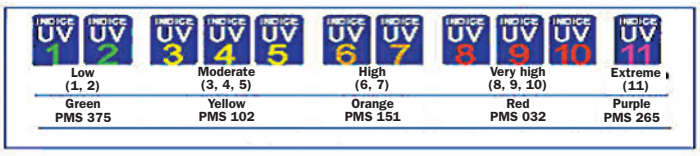
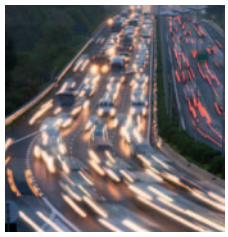


Figure 5.16: The numeric and colour coded classification of UV index values intended to make people take protective measures[23]

The values of the UV index provide a way in which people can be informed of potential risks incurred by exposure to UV rays.

[23] Source : http://www.epicentro.iss.it/problemi/uv/uv.asp



The UV index according to photo type provides information about the potential risks that prolonged exposure to the sun may incur. It can be seen that those with lighter coloured skin are most likely to burn even when the UVI index is as low as 6.

In addition to this numeric classification, index values have been grouped together according to photo types and the associated risks (Figure 5.17).

UV index	Photo-type			
	I	II	III	IV
1 2	Low	Low	Low	Low
3 4	Medium	Low	Low	Low
5	High	Medium	Low	Low
6	Very high	Medium	Medium	Low
7	Very high	High	Medium	Medium
8	Very high	High	Medium	Medium
9	Very high	High	Medium	Medium
10	Very high	High	High	Medium

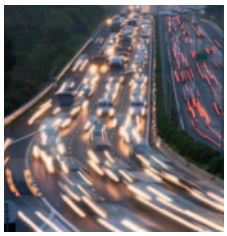
Figure 5.17: Possible risk incurred by exposure to UV rays[24]

It can be seen therefore, that the fundamental importance of making members of the public aware of the UVI index increases as conditions become even more extreme and the danger or potential danger from excessive exposure to UV rays rises accordingly. It is normal for such conditions to be present in the latitudes within which Italy lies both in the summer and in areas with high levels of snow in the winter.

The epidermis is sensitive to only some of the rays to which it is exposed.

The measurements of the UV index represent an evaluation of the amount, or in other words, the quantity of energy that strikes a surface over a unit of time. In this case, where it is the effects on man that are of interest, the surface in question is the skin (epidermis) that is exposed to the sun (the epidermis). The amount needed to cause irritation (an erythema) varies according to the characteristics of a particular skin type. Information regarding how to protect oneself and avoid the damage incurred by prolonged exposure to the sun must refer to both the UVI and photo type if it is to be useful.

[24] Source: ARPA Friuli Venezia Giulia



Available data

Over the last two years, ISPRA, in accordance with the agency system, has collected and collated all available data and information provided from across the nation.
Considering that to date, Italy has only limited experience on this issue, the limited data available obviously lacks uniformity and is extremely variable. Never the less, it does underline the country's commitment this innovative subject.
The Figure 5.18 clearly shows that only two branches of ARPA (Aosta Valley and Piedmont) regularly carry out monitoring activities, and that a third (Basilicata) is able to provide forecasts based on mathematical models. There are six Agencies nationwide that provide informative bulletins and carry out monitoring activities of one type or another. Interest in the subject matter throughout the agency system however, can be seen from the various UV related activities that are in fact carried out by 19 of the 21 agencies.

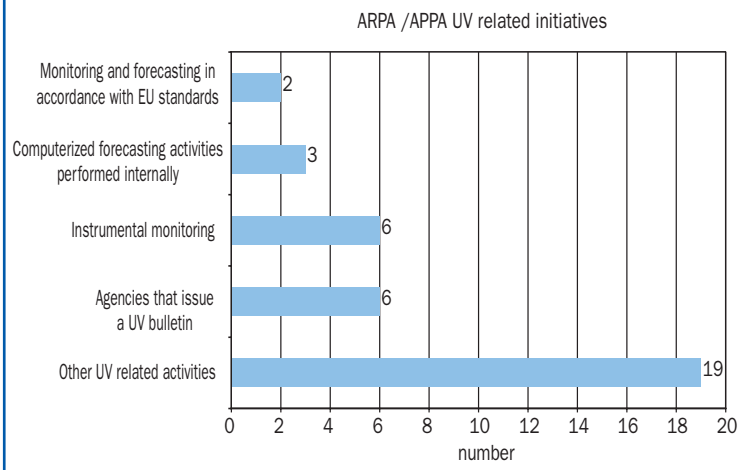
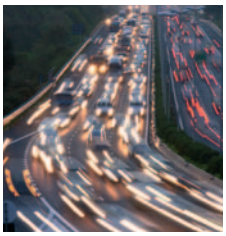


Figure 5.18: UV related activities carried out by ARPA/APPA[25]

Two branches of ARPA (Aosta Valley and Piedmont) adopt criteria and procedures that are in line with European standards. A total of 19 out of 21 branches carry out UV related activities.

[25] Source: ISPRA



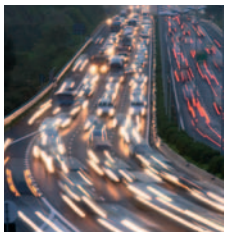
The data that follows regards only the regions of the Aosta Valley and Piedmont in that to date; they are the only regions who have adopted methods and procedures in line with European standards. The purpose of the activities carried out by the Aosta Valley branch of ARPA is to:

- Evaluate the medium and long-term trends regarding solar UV radiation at ground level in relation to variations in stratospheric ozone. They are joined, in this task, by the Physics Department of Rome's "La Sapienza" University, which has a consolidated experience in the study of ultraviolet radiation, and can boast of almost twenty year's worth of records of data obtained by the University's own campus-based station.
- Obtain data that will contribute to a more in-depth understanding of the interaction between the UV component of solar radiation and the atmosphere, which will also lead to a greater understanding of the dynamics of photochemical smog.
- Evaluate the effects of exposure to solar UV radiation on a large number of people who are, for either professional or leisure reasons, involved in activities carried out at altitude. This is another area of collaboration with Rome's "La Sapienza".

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).

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.



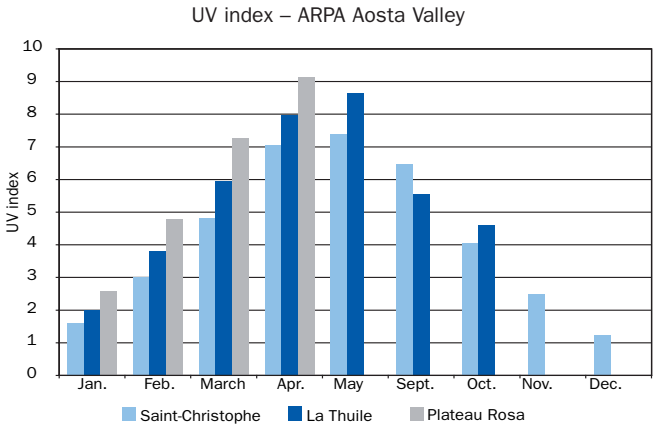


Figure 5.19: UV index, maximum value by month (2008)[26]

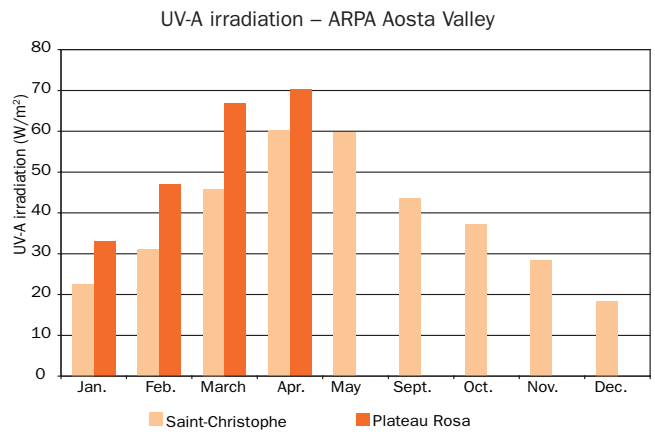
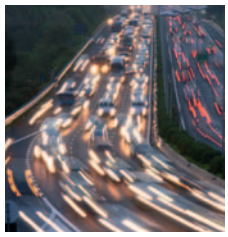


Figure 5.20: Ultraviolet irradiation in the UV-A range, maximum value by month (2008)[27]

Levels of UVI show a steady increase between January and the end of May, and the highest values are recorded at the Plateau Rosa site, which is located at altitude and is usually covered in snow. This highlights how factors such as local albedo, altitude and orography affect index values. The situation regarding irradiation values is analogous.

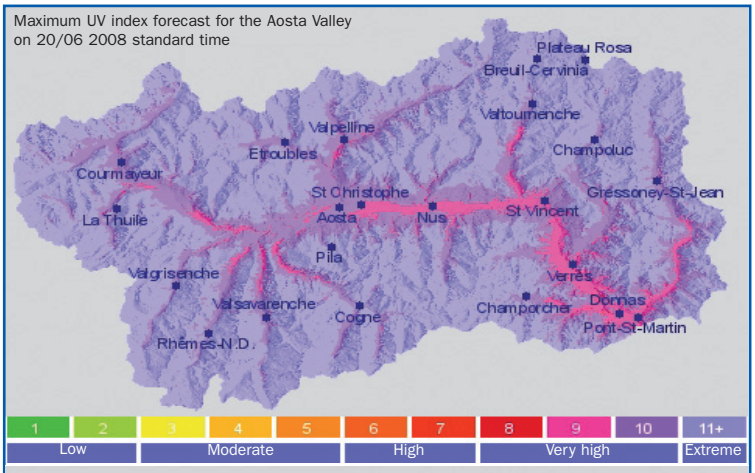
[26] Source: ARPA Aosta Valley
Note: Data for June, July and August is missing as that is when the radiometers were being calibrated

[27] Source: ARPA Aosta Valley
Note: Data for June, July and August is missing as that is when the radiometers were being calibrated



The Figure 5.21 below shows examples of the UV index throughout the Aosta Valley area as shown in the forecast bulletin posted on the Agency's website.

The highest values are recorded at the highest altitudes, which confirms the findings of the data collected.



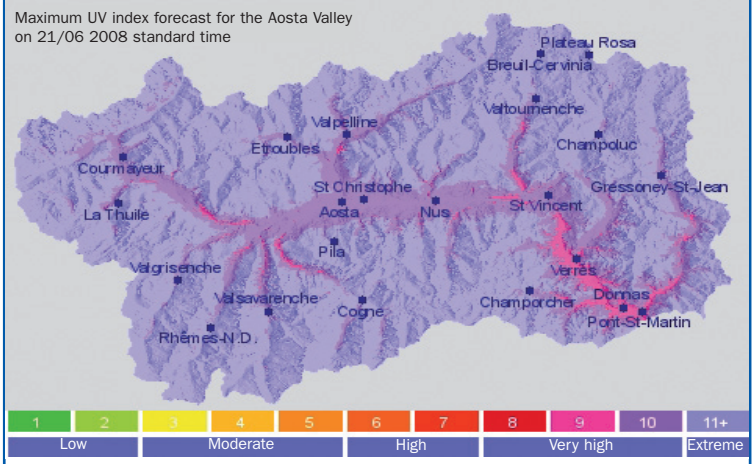
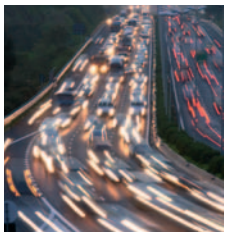


Figure 5.21: Example of a forecast notice for the moments immediately before and after the summer solstice (between 20 and 21 July)[28]

[28] Source: ARPA Aosta Valley
Note: Data for June, July and August is missing as that is when the radiometers were being calibrated



Piedmont is the second region to create a monitoring network that conforms to European standards. As to the disposition of the stations in Piedmont that measure UV: two have been established at a height of 270 m.a.s.l.in the headquarters of the Regional Centre for Ionising and Non-Ionising Radiation in Ivrea, in the Province of Turin, and there is another, at a height of 214 m, in the CNR Headquarters in Pallanza on Lake Maggiore. A third is located in Sestriere, in the Province of Turin at a height of 2,035 m.

Monitoring activities in both Sestriere and Pallanza only began at the beginning of August 2009 due to problems in calibrating the equipment. The graphs below show the maximum values in the UV index (Figure 5.22) and the highest irradiation values (Figure 5.23) recorded by each radiometer during the month of September. The results show that the highest irradiation and UVI values were recorded at Sestriere on 1st September 2009 at 11.45 CET and on the same day at Pallanza at 11.30 CET.

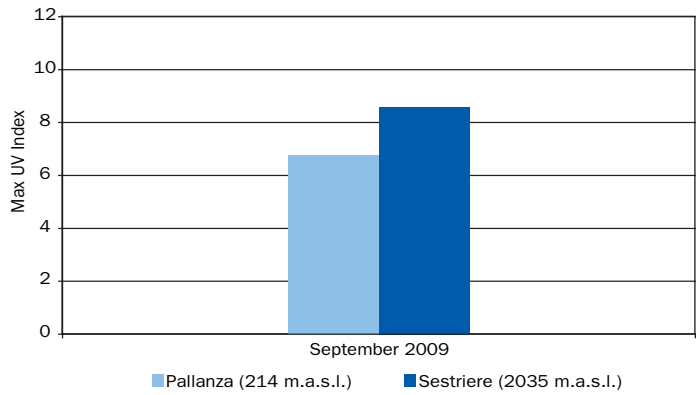
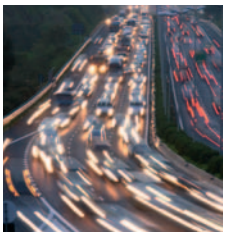


Figure 5.22: The highest UV index value recorded in September at Pallanza (at 214 m.a.s.l.) and Sestriere (at 2,035 m.a.s.l.)[29]

The highest irradiation and UVI values were recorded in Sestriere on 1st September 2009 at 11.40 CET and, in Pallanza, also on 1st September 2009 at 11.30 CET.

[29] Source: ARPA Piedmont



It can be seen that to date, the values of the location situated at a higher altitude are greater than those recorded in the other.

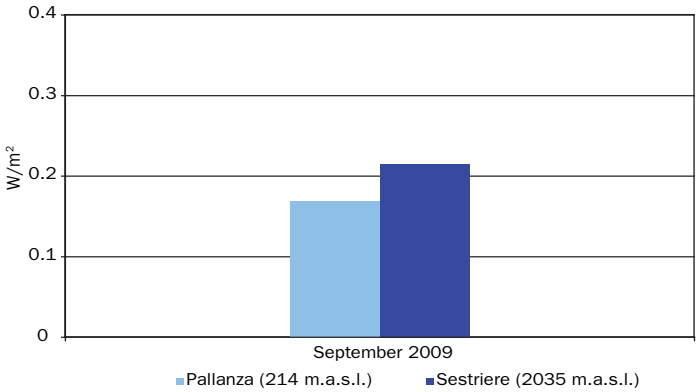


Figure 5.23: The highest irradiation value recorded in September at Pallanza (at 214 m.a.s.l.) and Sestriere (at 2,035 m.a.s.l.)[30]

A third graph, (Figure 5.24) below, shows the highest UV irradiation values recorded monthly during 2008 at Capanna Margherita and Colle Bercia, whilst the fourth (Figure 5.25), shows the highest UVI values recorded by the station in Ivrea during 2009.

The highest values were recorded in April in Colle Bercia and in May in Capanna Margherita. The latter consistently recorded higher values than the former except in the month of November.

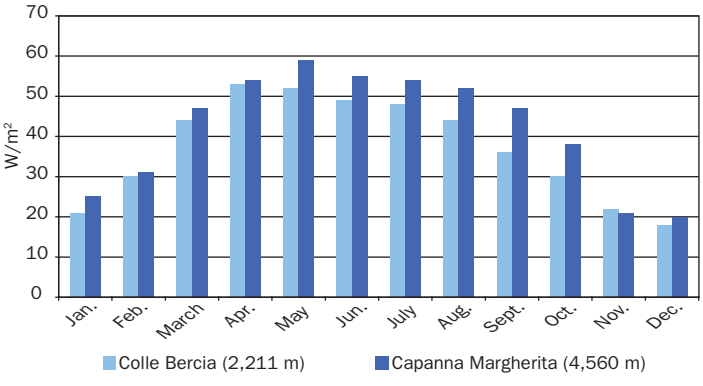
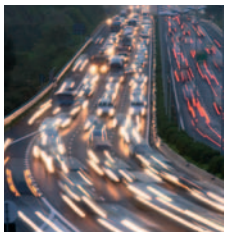


Figure 5.24: Totals of the highest monthly values of UV irradiation recorded in 2008 at Capanna Margherita (4,560 m.a.s.l.) and at Colle Bercia (2,211 m.a.s.l.)[31]

[30] Source: ARPA Piedmont
[31] Source: ARPA Piedmont



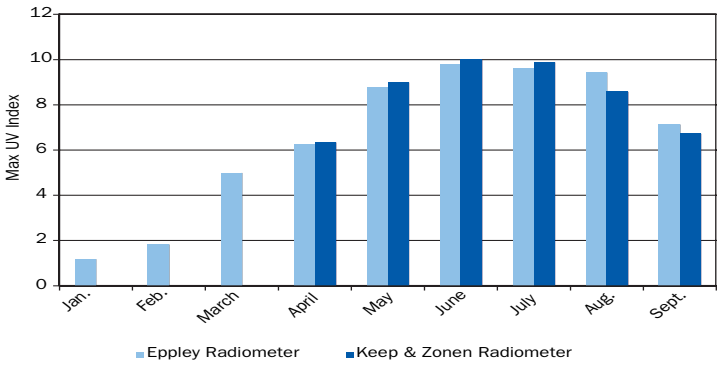


Figure 5.25: Highest UV index values recorded monthly during 2009 at Ivrea (214 m.a.s.l.) using 2 different radiometers[32]

The highest values recorded are in the months of June and July. Studying the graph closely shows that there is great similarity between the UV index values recorded by the two radiometers during the period April-September 2009 in that the difference between the two measurements is consistently less than 5%.

After an initial experimental phase, forecasting the UV index throughout Piedmont officially began on 1st July this year, with the publication of a daily forecast on the ARPA website: www.arpa.piemonte.it.
An example of this forecast bulletin can be seen in Figure 5.26.

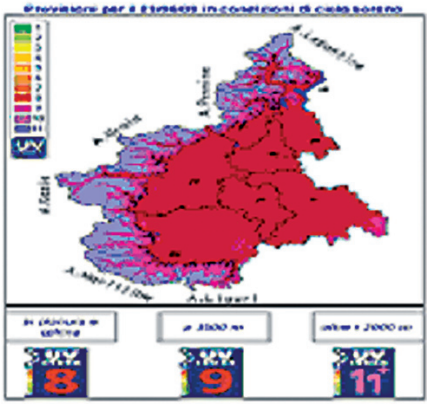
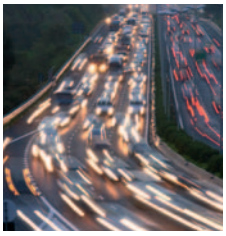


Figure 5.26: Bulletin forecasting the regional UV index released on 21 June 2009[33]

It can be seen that the UVI index value increases in line with the height above the plains. It follows therefore that forecasts made in Piedmont also show how the UVI index in effected not only by the irradiation at ground level but also by local factors such as height and albedo etc.

[32] Source: ARPA Piedmont
[33] Source: ARPA Piedmont

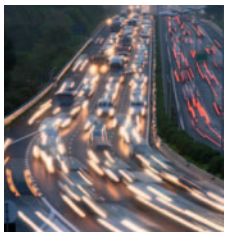


Other instances of the systematic gathering of data can be found in Friuli Venezia Giulia, where ARPA has three monitoring stations in two different coastal locations (Trieste and Grado), and one in the mountains (Mt. Zoncolan) equipped with an automatic filing system for the data collected. Due to calibration problems however, they are not currently operational. The APPA agency based in the autonomous Province of Bolzano also operates a station, sited on the Renon plateau, which measures irradiation weighted according to the erythemal equation but that data is not yet publically available. Both the Veneto and Emilia Romagna have a few stations from which they obtain data used for UVI index forecasts, which are then made available to the public on a fortnightly basis on the Agency's site. ARPA in Tuscany and Sicily each produce a UV index forecast in collaboration with third parties, which includes the level of protection to be used in relation to phototype (the Promote project, with ESA and other, private partners). In Sardinia, a bulletin on sun exposure times is provided as part of the privately funded CERU (Correct Exposure to Ultraviolet Radiation) project. This collaborative project involves Deutscher Wetterdienst, the Regional Agro-meteorological Service for Sardinia (S.A.R), a member of the National Research Council (CNR) as are fellow partners, the Bologna branch of the Institute of Atmospheric and Climate Sciences and the Sassari section of the Institute for Bio-molecular Chemistry. Lazio has recently established a prototype station to monitor UV rays in collaboration with ENEA (the Italian National Agency for New Technologies, Energy and Sustainable Economic Development). UV rays will be measured here at ground level in order to quantify the flow of ultraviolet radiation in relation to its effects on man. Initiatives that will provide the appropriate safeguards will follow. The Region of Basilicata publishes a UV index forecast on its website. Furthermore, it has been organizing campaigns to raise awareness of UV index values since 2005.

IONISING RADIATION

The problem

The general public often associate the term "ionising radiation" with the fear of the effects that this type of radiation has on health. The first image that these words conjure up, is associated with the direct effects of acute exposure, similar to burns, such as that of the explo-

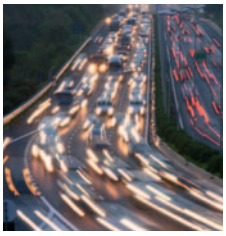


sion of nuclear bombs in Hiroshima and Nagasaki. Technically speaking, these burns are defined as "deterministic" effects and are the result of extreme exposure. Other fears concern the effects of less severe exposure that are not immediately noticeable but that manifest themselves over time or in future generations and they are often associated with the risk of cancer formation. A clear example of this is the fears that surfaced following the accident involving the Soviet nuclear reactor in Chernobyl and they are associated with the consequences of the entire population of a town being exposed. These effects are technically known as "stochastic", or in other words, probabilistic, in which the probability of them to occurr depends on the severity and duration of the exposure. It must also be stressed that in the collective imagination, ionising radiation is nearly always only associated with the production of nuclear energy, including the treatment and disposal of the waste it generates. The fear that 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 if the associated health and environmental risks are borne in mind. However, there are cases in which the exposure to ionising 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. What is more, the level of exposure must be "optimized" or in other words, reduced to the lowest levels that can reasonably be achieved.

A further consideration regards the entity of any exposure to which the population is generally subjected, compared to the exposure as described above. If atomic bombs and nuclear incidents are excluded in fact, then any exposure that results from activities associated with energy production is by far inferior to any that results from natural sources. There are sources of ionising radiating both in the cosmos and on the earth's crust, as well as within our own bodies, that are responsible for levels of exposure thousands of times higher than that

Ionising radiation is almost always only associated with the production of nuclear energy although in fact, exposure to ionising 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.



These considerations point out the need to find out more and to increase awareness of the repercussions of being exposed to sources of ionising radiation. Therefore, evaluating the risks and benefits associated with all sources of radiation becomes easier and is better understood.

produced by the nuclear industry. The main source of exposure to ionising radiation occurs in a domestic setting and in other indoor situations, 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 generally the main source of the risks that everyone has to face. 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 point out the need to find out more and to increase awareness of the repercussions of being exposed to sources of ionising radiation.Therefore, evaluating the risks and benefits associated with all sources of radiation will become less difficult and better understood.

Radon exposure

A national overview of the situation with regard to radon exposure was obtained following an investigation carried out in the 80s and 90s, which, because of the characteristics of the phenomenon, is still valid (Figure 5.27).

High concentrations of radon (Rn-222) have been noted in Lazio and Lombardy. The difference between these regions and the others is due to the high uranium content in the rocks and soils and their diverse permeability.

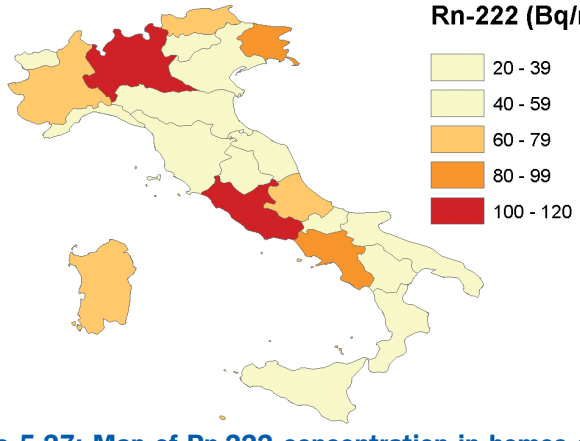
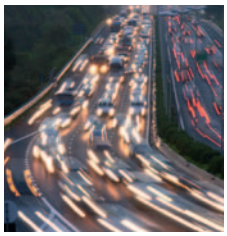


Figure 5.27: Map of Rn-222 concentration in homes shown by region and autonomous province (the choice of scale used is of purely exemplary value) (1989-1997)[34]

[34] 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

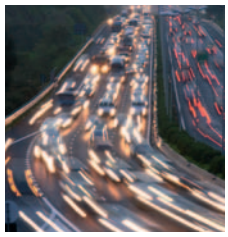


As to the response to this investigation, the problem of protecting the workplace from radon exposure was legally addressed with the enactment of the Legislative Decree no. 241 in 2000 that modified and integrated an earlier decree, no. 230 of 1995. The Decree sets out the obligations of both those in charge of workplaces and of the regions. The latter in particular are charged to identify the areas most likely to suffer high concentrations of radon activity. 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 started studies and investigations that will allow to classify areas according to the likelihood of high concentrations of radon being present. The regions in which such studies began are shown in Figure 5.28.
In conclusion, information on the decontamination efforts

Figure 5.28: The regions (in green) in which studies/initiatives aimed at identifying areas at risk of radon have been underway since 2002[35]

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 of ARPA /APPA started studies and investigations that will allow to classify areas according to the likelihood of high concentrations of radon being present.

[35] Source: ISPRA, ARPA/APPA



carried out in Italy in places where there is a high concentration of radon is still sketchy and erratic, whether in regard to domestic situations or the work place.

Controls on environmental radioactivity

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

Environmental radioactivity monitoring is organized, in compliance with both Italian law, under Legislative Decree 230/95 and its subsequent modifications, and European legislation as well, through a combination of networks that operate at three distinct levels: local, regional and national. Local networks are responsible for environmental radioactivity monitoring programmes on nuclear plants; regional networks are in charge of monitoring the level of radioactivity in the environment and foodstuffs in their respective territories, whilst national networks provide an overall picture of the situation in Italy and are responsible for collecting data and responding in the event of any anomalies. The diagrams below show the trend of Caesium-137 concentration in the airborne particulate, in the wet and dry deposition and in cow's milk

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).

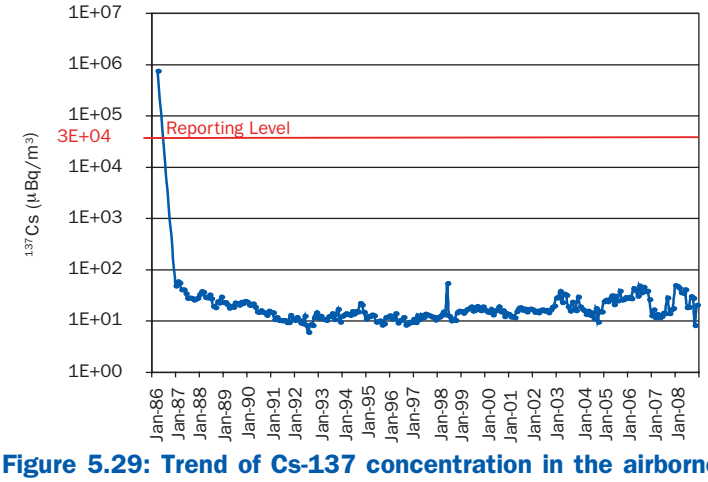
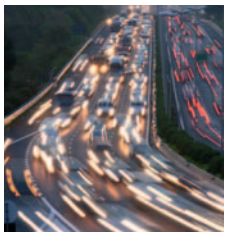


Figure 5.29: Trend of Cs-137 concentration in the airborne particulate in Italy[36]

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



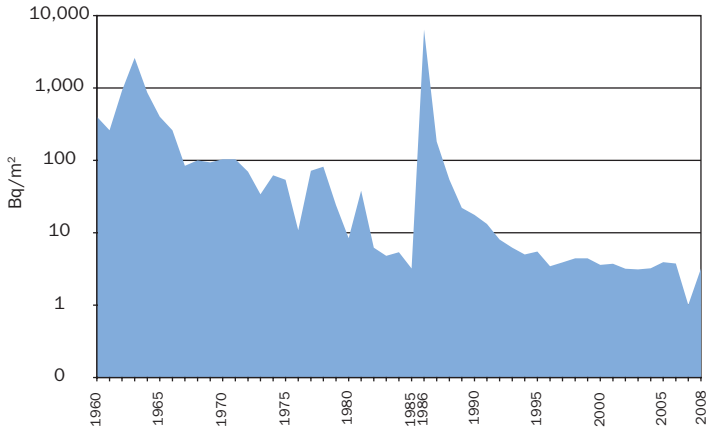


Figure 5.30: Trend of wet and dry deposition of Cs-137 in Italy[37]

This diagram highlights the high Cs-137 concentration 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.

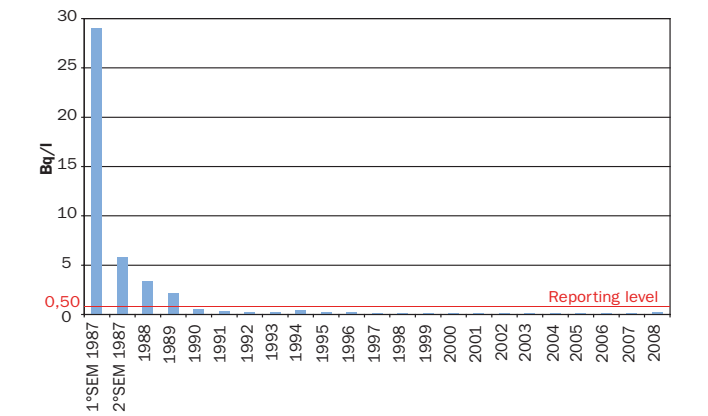
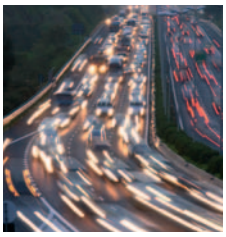


Figure 5.31: Trend showing the concentration of Cs-137 in cow's milk in Italy[38]

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, whilst levels have been below the reporting level established by the EU (0,5 Bq/l) since 1990.

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

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



over a period of years (Figures 5.29, 5.30 and 5.31).
The answer to obtaining an overall view of the situation in Italy is provided by the pursuit of a network-monitoring programme.
Table 5.3 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.
The evaluation of each of these matrices was based on all the following aspects: frequency of measurements taken, the sensitivity of these measurements, territorial coverage of controls, regularity of monitoring, the organization and participation in intercomparison exercises on a nationwide basis.

The score given to the national monitoring programme is satisfactory, even if the coverage of the entire national territory has to be improved.

Table 5.3: Evaluation of the state of monitoring carried out over national[39]

Year	Score	Finding
1997	15	satisfactory
1998	17	satisfactory
1999	13	insufficiente
2000	17	satisfactory
2001	17	satisfactory
2002	17	satisfactory
2003	17	satisfactory
2004	17	satisfactory
2005	17	satisfactory
2006	17	satisfactory
2007	17	satisfactory
2008	17	satisfactory

Key: Quality levels: unsatisfactory 0- <15; satisfactory 15- <21; good 21<25

The score given to the national monitoring programme is satisfactory, even if the coverage of the entire national territory has to be improved.

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